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# The Finishing of Jute & Linen Fabrics

BY

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# PREFACE

OF the many important branches of the textile industry that which deals with the finishing of fabrics has received the least attention from those who have written on textile subjects, and hence the publication of the present volume.

That there is need of such a work as the present one is proved by the numerous enquiries which have been made from time to time by students, and also by these who are more intimately acquainted with the subject.

A large part of this work appeared in serial form from 1907 to 1915 in *The Textile Manufacturer*, but during this period several innovations in finishing were made, and those which are considered by the author to be the most important have been introduced into the book; in addition, several of the original drawings have been discarded and replaced by new ones, while others have been altered in order to bring the work up to date.

There are altogether 390 illustrations in 255 figures, and 46 of the latter were made by Mr T. Milne, who was associated with me in the earlier part of the work.

The author takes this opportunity of thanking the machine makers and others who have rendered valuable assistance, and the publishers and printers for the excellence of their work.

T. WOODHOUSE

*September* 1916

# CONTENTS

## CHAPTER I

PAGE
INTRODUCTION . 1-3

## CHAPTER II

CROPPING OR CUTTING . . 4-16

No. *Illustrations*

1. Cutting Spiral . . . . 5
2. Details of Spiral Blades . . . 6
3. End Sectional Elevation of Urquhart, Lindsay & Co.'s Double Spiral Cropper . . . . . . . . 6
4. End Sectional Elevation of Urquhart, Lindsay & Co.'s Quadruple Spiral Cropper . . . . . . . 7
5. End Sectional Elevation of Scrubbers and Brushes for Cropping Machines . . . . . . . . 7
6. Front Elevation of Urquhart, Lindsay & Co.'s Quadruple Cropper 8
7. End Elevation of Driving Side of Urquhart, Lindsay & Co.'s Quadruple Cropper . . . . . . . . 9
8. End Elevation opposite to Driving Side of Urquhart, Lindsay & Co.'s Quadruple Cropper . . . . . . . 10
9. End Elevation of Parts for End-long Movement of Spirals 11
10. Front Elevation of Parts for End-long Movement of Spirals . . 11
11. End Elevation of A. F. Craig & Co.'s Quadruple Cropper . 12
12. Various Types of Rails for Cropping Machines . 13
13. Photographic View of a Quadruple Cropping Machine . 14
14. Photographic View of a Row of Cropping Machines fitted with Dust Collecting Apparatus . . . . . . 15

## CHAPTER III

DAMPING . . . . . 17-21

No. *Illustrations*

15. End Sectional Elevation of Parker's Double Brush Damping Machine 19
16. Plan of Parker's Double Brush Damping Machine . . . 19
17. End Elevation of Parker's Double Spray Damping Machine . . 20

## CHAPTER IV

PAGE
CALENDERING AND CHESTING . . . . . . . 22-38

No. *Illustrations*

18. End Elevation of Robertson & Orchar's 5-Bowl Calender . 23
19 Elevation of Delivery Side of Robertson & Orchar's 5-Bowl Calender 23
20 General View of Robertson & Orchar's 5-Bowl Calender . 25
21. Photographic General View of a Row of Calenders 29
22. Photographic View of a 5-Bowl Calender . . 30
23 Eight Different Methods of Railing or Tensioning the Cloth in Calenders . . . . 34
24. Direction followed by Cloth for Light Calender Finish 35
25. Direction followed by Cloth such as Sackings . . 35
26. Direction followed by Cloth for Heavy Calender Finish 35
27. Direction followed by Cloth for Ordinary Chest Finish . . 35
28. Direction followed by Cloth for Heavy Chest Finish . 35

## CHAPTER V

MANGLING . . . . . . . 39-72

No. *Illustrations*

29. Elevation of Feed Side of Thomson, Son & Co.'s Stone Mangle Beaming Machine . . . . . . . . 42
30. End Elevation of Thomson, Son & Co.'s Stone Mangle Beaming Machine . . . . . 42
31. Front Elevation of Stone Mangle . . 43
32. Plan of Stone Mangle . . . 43
33. Sectional Elevation of Gearing of Stone Mangle . 44
34. End Elevation of Stripping Machine . . . 46
35. Elevation of Delivery Side of Stripping Machine . . 47
36. Diagrammatic View of Pins and their Path in Hydraulic Mangle . 48
37. Plan of Urquhart, Lindsay & Co.'s Hydraulic Mangle . . 50
38. Elevation of Feed Side of Urquhart, Lindsay & Co.'s Hydraulic Mangle 51
39. End Elevation of Driving Side of Urquhart, Lindsay & Co.'s Hydraulic Mangle . . . . . . . . . 52
40. End Elevation opposite to Driving Side of Urquhart, Lindsay & Co.'s Hydraulic Mangle . . . . . . . . . 53
41. Plan of Self-Acting Reversing Gear of Hydraulic Mangle . . 56
42. End Elevation of Self-Acting Reversing Gear of Hydraulic Mangle 56
43. Sectional Front Elevation of Self-Acting Reversing Gear of Hydraulic Mangle . . . . . . . . . . 57
44. Elevation showing Method of Connecting Self-Acting Reversing Gear to Mangle . . . . . . . . . 58
45. Front Elevation of Accumulator . . . . . . 61
46. Plan of Accumulator with Pipes to Hydraulic Mangle . . 62
47. End Elevation of Urquhart, Lindsay & Co.'s Hydraulic Mangle, showing sections of several Interior Parts . . . . 63
48. Sectional Front Elevation of one Frame of Urquhart, Lindsay & Co.'s Hydraulic Mangle . . . . . . . . 63
49. Elevation of Accumulator Pipes from Accumulator to Mangle . . 67

No. *Illustrations* PAGE
50. Elevation of Pipes between the Two Frames of Mangle 68
51. Plan of Pipes from Accumulator to Mangle . . 68
52. Photographic View of Switch-Board, Motor and Part of Feed Side of Hydraulic Mangle . . . . . 69
53. Photographic View of Feed Side of Hydraulic Mangle . 70
54. Photographic View of Delivery Side and End Opposite to Driving of Hydraulic Mangle . . . . . . 70
55. Photographic Views of Cloth Loom State and Calender Finish 71
56. Photographic Views of Cloth. Chest Finish and Mangle Finish 71

## CHAPTER VI

MEASURING, MARKING AND ROLLING . . 73-83

No. *Illustrations*
57. End Elevation of Urquhart, Lindsay & Co.'s Measuring Machine . 73
58. Plan of Urquhart, Lindsay & Co.'s Measuring Machine . 73
59. Clock Face for Indicating Length in Measuring Machine 74
60 End Elevation of Wheels and Hands of Clock . . 75
61 Plan of Wheels and Hands of Clock . . . 75
62. Elevation of End opposite to Driving End of Robertson & Orchar's Measuring, Marking and Rolling Machine . . 77
63 Elevation of Driving End of Robertson & Orchar's Measuring, Marking and Rolling Machine . . . . . . 78
64. Elevation of Feed Side of Robertson & Orchar's Measuring Marking and Rolling Machine . . . . . . 80
65 Plan of Robertson & Orchar's Measuring, Marking and Rolling Machine . . . . . . . . 81
66 Enlarged View of Part of Marking Apparatus of Robertson & Orchar's Measuring, Marking, and Rolling Machine . 83

## CHAPTER VII

CRISPING AND ROLLING . 84-94

No. *Illustrations*
67. Side Elevation of Urquhart, Lindsay & Co.'s Crisping Machine 87
68. Plan of Urquhart, Lindsay & Co.'s Crisping Machine . . 87
69. End Elevation of Urquhart, Lindsay & Co.'s Crisping Machine 88
70 End Elevation of Calenderoy . 89
71. Side Elevation of Calenderoy . . 90
72 Sections of Spits . . . 91
73. Elevation of Delivery Side of A. Bicket's Crisping and Rolling Machine . . . . . . . . . 92
74. Elevation of Driving Side of A. Bicket's Crisping and Rolling Machine . . . . . . . . . 93
75. Sectional View of Guide, Rollers, Cloth and Spit in A. Bicket's Crisping and Rolling Machine . . . . . . 94

## CHAPTER VIII

PAGE
LAPPING, FOLDING, OR PLAITING . . . . 95-118

No. *Illustrations*

76. Side Elevation of Hacking & Co.'s Folding or Plaiting Machine . 97
77. Sectional Elevation of Hacking & Co.'s Plaiting Machine Showing Method of Operating Grip Rails . . . 99
78. Plaiting Machine with Oscillating Table . 102
79. 80. 81. Diagrammatic Views illustrating the Plaiting Knives in Three Different Positions . . . . . . . 105
82. Side Elevation of Hattersley's Folding or Plaiting Machine . 107
83. Plan (partly sectional) of Hattersley's Plaiting Machine . . 107
84. Elevation of Feed End and details of Automatic Stop Motion in Hattersley's Plaiting Machine . . . 107
85. Side Elevation of Hacking's Folding or Plaiting Machine with Semi-Concave Table . . . . . 113
86. Sectional Elevation of Hacking's Plaiting Machine Showing Method of Altering Strength of Spring . . . . 115
87. Plan of Springs, etc., in Hacking's Plaiting Machine . 117

## CHAPTER IX

PACKING . . . . . . . 119-141

No. *Illustrations*

88. Side Elevation of Urquhart, Lindsay & Co.'s. 18 in. Single Ram Hydraulic Press . . . . . . . . 120
89. End Elevation of Urquhart, Lindsay & Co.'s 18 in. Single Ram Hydraulic Press . . . . . . 120
90. Side Elevation of 17 in. Double Ram Press . . 120
91. Plan of Top Plate of Hydraulic Press . 120
92. Plan of Four Uprights and Ram of Hydraulic Press . . 120
93. Plan of Moving Table of Hydraulic Press . . 120
94. Sectional Elevation of Steel Cylinder, also Ram and Table of Hydraulic Press . . . . . . . . 123
95. Plan of Table and Apparatus for Rope Binding in Hydraulic Press 124
96. Elevation of Hydraulic Press with Packed Bale between Plates 124
97. Details of Hoops, Buckles and Pins for Hoop Binding 126
98. Side Elevation of Hoop Cutter . . 127
99. Plan of Hoop Cutter . . . 127
100. Details of Hoops and Pins . . . 128
101. Plan of Hoop Bender with Hoop Bent . . 129
102. Side Sectional Elevation of Hoop Bender showing how Hoop is Bent 129
103. Side Elevation of Hoop Bender and Hoop before Bending Starts 129
104. Details of Cam, etc., for withdrawing Pin after Hoop is Bent 131
105. Front Elevation of 8-Barrel Vertical Pumps . . . 132
106. Plan of 8-Barrel Vertical Pumps . . . . . 133
107. Sectional End Elevation of 8-Barrel Vertical Pumps . . 134
108. Elevation of Low-Pressure End of 8-Barrel Vertical Pumps 136
109. View of Parker's 8-Barrel Vertical Pumps . . 138
110. Front Elevation of One Plunger and Driving Wheels of Parker's 8-Barrel Vertical Pumps . . . . . 140
111. End and Sectional Elevation of Parker's 8-Barrel Vertical Pumps . 140

## CHAPTER X

PAGE
BAG OR SACK-CUTTING FRAMES AND MACHINES . 142-161

No. *Illustrations*

112. Side Elevation of Hand-Cutting Frame and Table 143
113. Plan of Hand-Cutting Frame and Table 143
114. End Elevation of Cutter, Table and Frame . . 144
115. Side Elevation of Hand-Cutting Frame and Table for Long Lengths 146
116. End Elevation of Cutter and Table together with Enlarged View of Pencil Marker . . . 147
117. Side Elevation of Cutter, Drawing Rollers and Table of Hand-Cutting Frame . . . . . . 149
118. Elevation of Delivery Side of Parker's Power Sack-Cutting Machine . 151
119. Elevation of Driving End of Parker's Power Sack-Cutting Machine . 153
120. Elevation of End opposite to Driving End in Parker's Power Sack-Cutting Machine . . . . . . . . 155
121. Sectional End Elevation of Cloths, Grips, Knife, etc., in Parker's Power Sack-Cutting Machine . . . 155
122. Plan of Cloth, Knife, etc., in Parker's Power Sack-Cutting Machine 157
123. Plan and Elevation of Automatic Stop-Motion in Parker's Power Sack-Cutting Machine . . . . . 159
124. Diagram to illustrate Folding and Cutting of Irregular-Shaped Lengths . . . . 160

## CHAPTER XI

SACK OR BAG SEWING MACHINES . 162-202

No. *Illustrations*

125. Diagram to Illustrate Methods of Forming Bags . . 163
126. Diagram to Illustrate Formation of Seams and Hems 165
127. Elevation of Feed Side of Lock-Stitch Sewing Machine . . 165
128. Plan of Lock-Stitch Sewing Machine . . . . . 165
129. Elevation of Needle End of Lock-Stitch Sewing Machine . 165
130. Detail Plan of Cloth Guide, etc., in Lock-Stitch Sewing Machine 165
131. Cam, etc., for Lifting Needle Bar in Lock-Stitch Sewing Machine . 166
132. Details of Shuttle, Cop, Shuttle Carrier in Lock-Stitch Sewing Machine . . . . . . . . . 168
133. Elevation of Delivery Side of Lock-Stitch Sewing Machine . . 169
134. Elevation of Mechanism for Moving Foot Dog in Lock-Stitch Sewing Machine . . . . . . . . . 170
135. Diagram to Illustrate Time of Different Motions in Lock-Stitch Sewing Machine . . . . . . . 171
136. Cam for Moving Foot Dog in Lock-Stitch Sewing Machine . 171
137. Elevation of Cop Winding Machine . 173
138. Plan of Cop Winding Machine . . 173
139. End Elevation of Cop Winding Machine . 174
140. Details of Cop Winding Machine . 174
141. Types of Sewing . . . . . 175
142. Types of Sewing . . . . . . 175
143. Elevation of Feed Side of Yankee or Union Sewing Machine 177
144. Plan (partly Sectional) of Yankee or Union Sewing Machine 178
145. Elevation of Needle End of Yankee or Union Sewing Machine 179

No. *Illustrations* PAGE
146. Details of Yankee or Union Sewing Machine . . . 180
147A. } Six Different Positions of Looper, Needle, etc., in Yankee or Union { 181
147B. } Sewing Machines . . . . . . . . { 182
148. Diagram to Illustrate Times of Different Motions in Yankee or Union Sewing Machines . . . . . . . . 184
149. Photographic View of Sewing Flat fitted with Yankee or Union Sewing Machines . . . . . . . 185
150 Photographic View of Sewing Flat Fitted with Overhead Sewing Machines . . . . . . . . . 186
151. Front Elevation of "Laing" or Overhead Sewing Machine with Details of Needles, etc. . . 187
152 Plan of Overhead Sewing Machine 188
153 Sectional Plan of Overhead Sewing Machine . . . 188
154. Barrel and Friction Tube with connections of Overhead Sewing Machine . . . . . . . . . . 189
155 Elevation of Frame of Overhead Sewing Machine with Sectional View of Needle Drivers and details of Barrel . . . . 191
156. Photographic View of Macdonald's Model Z Overhead Sewing Machine . . . . . . . . . . 193
157. Details of Carriage in Model Z Overhead Sewing Machine . 195
158. Elevation of Delivery Side of Heracles Overhead Machine . . 196
159. Plan of Heracles Overhead Machine . . . . . 196
160. Elevation of Feed Side and Driving Arrangement of Heracles Overhead Machine . . . . . . . . . 198
161. Elevation of Needle End and Driving Arrangement of Heracles Overhead Machine . . . . . 199
162. View of Singer's Machine for zig-zag stitch 200
163. Straight and zig-zag stitches on Cloth . 201
164. Spool Support for Sewing Machines . . . 202

## CHAPTER XII

TWINE TARRING . . . 203-205

No. *Illustrations.*
165. Elevation of Twine Tarring Machine . . 204
166 Plan of Twine Tarring Machine . . . 204

## CHAPTER XIII

SACK AND BAG PRINTING . . . . . 206-228

No. *Illustrations*
167. Elevation of Keay's One-colour Sack Printing Machine (Driving Side) 207
168. Plan of Keay's One-colour Sack Printing Machine . . . 209
169. Elevation of Keay's One-colour Sack Printing Machine and details . 211
170. Elevation of Delivery End of Keay's One-colour Sack Printing Machine . . . . . . . . 212
171. } Photographic End View of Keay's One-colour Sack Printing Machine { 213
171A. } { 214
172. Photographic View of Sack Printing Department . . . 215
173. Elevation of Keay's Two-colour Sack Printing Machine . . 216

No. *Illustrations* PAGE

174.–177. Details of Chains and Grips for Travelling Cloth in Keay's Two-colour Sack Printing Machine . . . 217, 217, 218, 218
178. Elevation of D. J. Macdonald's Two-colour Sack Printing Machine . 219
179. Plan of D. J. Macdonald's Two-colour Sack Printing Machine . 221
180.–181. Details of Mechanical Stirrer in D. J. Macdonald's Machine 222, 222
182. Elevation of Driving Side of D. J. Macdonald's One-colour Sack Printing Machine . . . . . 223
183. Plan of D. J. Macdonald's One-colour Sack Printing Machine . 223
184. Elevation of Driving Side for Rollers and details in D. J. Macdonald's One-colour Sack Printing Machine . . 224
185. D. J. Macdonald's Numbering Machine for Sacks . . 226

## CHAPTER XIV

STARCHING, DYEING AND DRYING . 229-242

No. *Illustrations*

186. Elevation of Jigger for Starching . . 230
187. End Elevation of Jigger . . . 231
188. Plan of Jigger . . . . . . 231
189. Elevation of Mather & Platt's 3 Bowl Starching Calender and Horizontal Drying Pans or Cylinders . . . 232
190. Sectional Elevation of Starching Calender Bowls and Trough for Starching both sides of Cloth . . . . . . 233
191. Sectional Elevation of Mather & Platt's Starching Calender Bowls and Trough for Starching one side of Cloth . . . 233
192. Elevation of Mather & Platt's Vertical Drying Range . . 234
193. Plan of Vertical Drying Range . . . . . . 235
194. Diagrammatic View of continuous Starching, Dyeing and Drying Range . . . . . . . . 237
195.–196. Four Samples of Cloth dyed Black . . . . . . 238, 239

## CHAPTER XV

WATERPROOFING . . . . . . . . 243-246

No. *Illustrations*

197.–198. Eight Samples of Waterproofed and Starch Cloths . . 244, 245

## CHAPTER XVI

BLEACHING . . . . . . . . 247-259

No. *Illustrations*

199. Plan of Bleachworks . . . . . . 249
200. Elevation of Liming Machine . . . . . . 251
201. Plan of Liming Machine . . . . . . . 251
202. Sectional View of Lime Pot or Lime Boiling Kier . . . 251
203. Wince, Porcelain Guide and Cloth . . . . . . 255

## CHAPTER XVII

PAGE
SCUTCHING AND EXPANDING . . 260-270

No. *Illustrations*

204. Elevation of W. H. Harrop's Scutcher . . 261
205. Plan of W. H. Harrop's Scutcher . . . 261
206. Plan of Governor Rollers for Scutcher 262
207. Simple form of Scutcher . 262
208. View of Wm. Birch's Expander . . 263
209. Side Elevation of Wm. Birch's Bent Bar Expander . . 264
210. Front Elevation of Wm. Birch's Bent Bar Expander . 265
211. Plan of Wm. Birch's Bent Bar Expander . 265
212. End View of Wm. Birch's Bent Bar Expander 266
213. View of Wm. Birch's Bent Bar Expander . . . . . 267
214. Constructional View of Wm. Birch's Adjustable Bell-Crank Lever Expander . . . . . 267
215. View of Wm. Birch's Adjustable Bell-Crank Lever Expander . 267
216. Elevation (part sectional) of W. H. Harrop's Revolution Expander 268
217. Plan (part sectional) of W. H. Harrop's Revolution Expander 269

## CHAPTER XVIII

STENTERING, JIGGING, GUIDING AND FEEDING . 271 286

No. *Illustrations*

218. 219. End Elevation and Plan of J. H. Riley & Co.'s Starching, Drying and Stentering Machine . 273, 273
220. 221. 222. 223. 224. Two End Views and Three Side Views of Grips for Stenter Rails . 274, 274, 275, 275, 276
225. End Elevation of Foxwell's Automatic Guider and Feeder with Combined Air Compressor and Receiver . . 277
226. Plan of Foxwell's Automatic Guider and Feeder . 279
227. Side Elevation of J. H. Riley & Co.'s Jigging Stenter 282
228. Plan of J. H. Riley & Co.'s Jigging Stenter . . . 283
229. Elevation of Delivery End of J. H. Riley and Co.'s Jigging Stenter . 285

## CHAPTER XIX

BELT STRETCHING, CALENDERING, CHASING AND BEETLING . . . . . . . . . 287-307

No. *Illustrations*

230. Sectional Elevation of J. H. Riley & Co.'s Belt Stretching Machine 289
231. Plan of J. H. Riley & Co.'s Belt Stretching Machine . . 289
232. Sectional Elevation of Mather & Platt's 3-Bowl Calender . . 291
233. End Elevation of A. Edmeston & Sons', Ltd., Wood Faller Beetling Machine . . . . . . . . . 293

No. *Illustrations* PAGE
234. Part Plan of A. Edmeston & Sons', Ltd. Wood Faller Beetling Machine . . . . . . . . . 295
235. Elevation of Driving End of A. Edmeston & Sons', Ltd. Wood Faller Beetling Machine . . . . . . 296
236. Detailed Plan of Driving Mechanism of A. Edmeston & Sons', Ltd. Wood Faller Beetling Machine . . . . . . . 297
237. Elevation of Feed Side of Mather & Platt's Patent Spring Beetling Machine . . . . . . . . . . 301
238. Elevation of Driving End of Mather & Platt's Patent Spring Beetling Machine . . . . . . . . 302
239 Elevation of Opposite End of Mather & Platt's Patent Spring Beetling Machine . . . . . 304
240. Side Elevation of Mather & Platt's Patent Spring Hammer . . 305
241. Front Elevation of Mather & Platt's Patent Spring Hammer . 305

## CHAPTER XX

RNAMENTATION BY HEMSTITCHING, EMBROIDERY, AND SIMILAR MECHANICAL OPERATIONS . 308-319

No. *Illustrations*
242. Various Types of Hemstitching . . . . . 309
243. Diagrammatic View of Forward and Return Hemstitch . . 311
244. Three Rows of Hemstitching and Two Plaits on Fabric . 312
245. Four Types of Corded Ornament on Fabrics . . . 313
246. Two Types of Scallop on Fabric . . . 313
247. Embroidered Leaves and Flowers on Fabric . . . 314
248. View of Singer Manufacturing Co.'s Ltd. Embroidery Machine . 315
249. Singer Manufacturing Co.'s, Ltd. Pantograph Embroidery Machine . 316
250. Embroidered Initials in Old English done on Pantograph Embroidery Machine . . . 317
251. Partially Mended or Darned Fabric . . . 318
252. Wholly Mended or Darned Fabric . . . . . 318
253. Singer Manufacturing Co.'s, Ltd. Mending or Darning Machine . 318

# THE FINISHING OF JUTE AND LINEN FABRICS

## CHAPTER I

### INTRODUCTION

It is an almost invariable custom to submit a woven fabric, after it leaves the loom, to a course or process of treatment which is calculated to enhance its appearance and value, and, in general, to render it more fit to fulfil the purpose for which it is intended; such treatment, however, may not, in all or even in many cases, increase its qualities of durability or resistance to wear and tear. Such a process is generally known by the appropriate and comprehensive title of "finishing." Jute and linen fabrics form no exception to this almost universal rule, and in this work we purpose describing the processes of finishing and making-up of these goods, and, in addition, illustrating and explaining the various machines in use in these processes. We shall also describe the process and the principles involved in the bleaching of linen and union fabrics, and supplement this by illustrations of the necessary machinery.

While there is in many instances a striking difference between a jute or a linen fabric in the "loom" or "rough" condition, as compared with the highly finished state, yet such cloths, even when heavily mangled, retain in a marked degree the characteristics which were present in the loom cloth. This is due to the fact that jute and linen fibres have no power of felting together like the wool fibre, and that, therefore, finishing generally is restricted to the flattening of the individual threads of the cloth in a greater or lesser degree. Such being the case, the finishing of jute and linen goods, neglecting bleaching, may be considered in many respects a comparatively simple process, or rather a number of simple processes, yet it is of sufficient importance to merit a considerable measure of attention from all engaged in the trade. The various stages through which ordinary jute and heavy linen fabrics pass from the loom to the finished condition are few in number, yet many different types and degrees of finish are imparted to them, while the machines involved, although generally simple in character, are often of huge dimensions, and are, in most cases, excellent examples of the engineers' skill.

Since the term "finishing" is general, and embraces every process through which the cloth passes from the time it leaves the loom until it is ready for delivery, it may be well to indicate the chief sub-divisions of the process. Any piece of jute or linen cloth which is to be delivered in the piece or long-length form may be subjected to all or many of the following processes: picking or inspecting, cropping, damping, calendering, mangling, measuring, crisping, lapping or rolling, and packing. In addition to these more general processes we may add that, for certain purposes, it may be necessary for the fabric to pass through some of the following processes: washing, blueing, bleaching, dyeing, stencilling, stiffening, weighting, waterproofing and drying. Large quantities of both classes of fabrics are so treated, while a considerable quantity may require to be cut up into certain defined lengths or sizes, and made into useful articles of various kinds. Amongst these may be mentioned tablecloths, serviettes or napkins, doylies, hand and roller towels, sheets, mattresses, ticks, aprons, pillow cases and bolsters, handkerchiefs, glass and other cloths, dusters, rubbers, toilet requisites, and various kinds and sizes of bags, and of covering cloths. It is necessary to perform this cutting by hand for those cloths which possess a figured or well-defined pattern, but in the case of the plain or simple weaves the cloths may be cut and made up either by hand or by machine. Similarly, either method may be adopted for bag printing, by which process the name of the customer and any other desired particulars may be impressed in one or more colours on the articles. On the other hand, a comparatively small quantity of goods may be simply measured and made up for despatch without any further attempt at finishing.

Practically all jute and linen fabrics undergo some form of examination subsequent to weaving, in order that any defects occurring in the latter process may be detected and remedied by darning or otherwise before the goods are passed over to the finishing departments. At this stage the cloth is also picked and cleared of all thick places of weft, knots, loose threads, etc., which, if not removed, might cause the piece to be damaged during its passage through the cropping machine. A large proportion of the coarser jute goods, such as sackings and baggings, is never submitted to this process of inspection, nor to the subsequent cropping operation. Nevertheless, it is most desirable that all pieces should be inspected, whether they are afterwards to be cropped or not, as careless weavers often leave darning needles and other equally undesirable articles in the piece, and thus unintentionally cause considerable damage to the cloth when it is subjected to the heavy pressure of the finishing proper. For the purpose of inspection, a good heavy inclined table of sufficient length and breadth is usually provided, and the cloth pulled over this table by hand, or by mechanism operated by the foot. In some cases the cloth is passed over suspended rollers or guides, so that, as it descends upon the table, it passes between the cloth inspector and a good light, thus showing up defects which would otherwise be difficult, and in certain cases impossible to detect. At other times the loom cloth beam is taken direct to the measuring machine where the cloth is roughly examined as it passes over the table of the machine. Doubtful pieces then undergo a closer examination.

# CHAPTER II

## CROPPING OR CUTTING

**Cropping or Cutting.**—Cropping may be considered as the first mechanical operation in finishing, and is usually the first process undertaken by a public finisher. It has for its object, as its name implies, the removal, by mechanical means, of all projecting fibres from the surface of the fabric. The process is considered essential for all the finer classes of the jute goods, such as hessians, tarpaulins, fine sackings, etc., and for all linen fabrics. It results in a distinct improvement in the appearance of the cloth, which appears much smarter, cleaner, and more lustrous than an uncropped piece of the same make and quality. The cropping-machines in general use are usually fitted with either two or four cutting spirals, and are therefore known as "double" or "quadruple" croppers. In some few cases three spirals are fitted, and hence we have the term "triple" cropper. In machines fitted with two spirals only, both sides of the cloth are cropped once in one operation. This may be sufficient if the machine is in very good order, but in many cases satisfactory results can only be obtained by passing the cloth twice through such a machine. At the second run the attendant should be careful to see that the top side of the cloth in the first instance is the under side in the second, and that the end of the piece which has just emerged from the machine is entered first for the second run through. The first precaution ensures both sides of the cloth being operated upon by both spirals, and therefore more equal cropping, for it is not unusual to find one spiral more effective than the other; the second precaution has for its object the removal of any curvature of the weft which may have been caused by the "railing" of the piece during the first operation. To avoid the labour of removing the pieces from the delivery side to the feed side of the machine after the first run through, and also to increase production, two double spiral machines are often arranged to work together. In such a case one machine is situated immediately behind the other so that the passage of the cloth may be continuous. When a "quadruple" cropping machine is used it is generally necessary to run the cloth through once only, since the four spirals are arranged to crop the cloth twice on each side during one passage through the machine.

All cropping machines are constructed on the same general principle, the active apparatus in every case consisting of one or more revolving and cutting spirals similar to that shown in Fig. 1. Each spiral consists of a cylindrical metal foundation B of about four to five inches in diameter, and 90in. or upwards in length—the length depending upon the greatest width of cloth which the machine will be required to treat. The ends A are reduced in diameter to suit bushes, pulleys, etc. Firmly secured to this cylinder, and arranged around it in a very open spiral or screw form, are eight or ten hard steel cutting blades, C, each about $\frac{3}{4}$in. deep and $\frac{1}{32}$in. thick. Originally these blades had plain sides as shown at D (Fig. 2), and were arranged singly around the central cylinder; the more modern method is to make them in pairs and in channel form, as illustrated at E. These blades are then securely fixed to the discs of the cylinder B (Fig. 1), by bolts D. In addition the blades now have right or left hand file-cut, or over-cut, sides as represented by A, B, and C respectively (Fig. 2). A section of a single file-cut blade appears at F. The excellent results obtained by the use of quadruple spirals is chiefly due to the fact that a right and a left hand file-cut spiral act upon each side of the cloth. This arrangement reduces the probability of missed fibres almost to the vanishing point, and as a result, Messrs Henry Rossell and Co., Sheffield, have introduced the "over-cut" spiral blade (see C and E, Fig. 2), which is a combination of a right and left hand file-cut. If a double spiral machine be fitted with blades of the over-cut type,

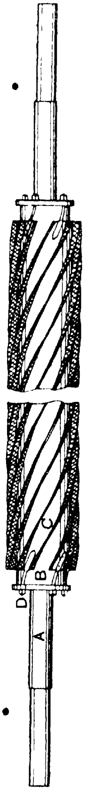


Fig. 1.

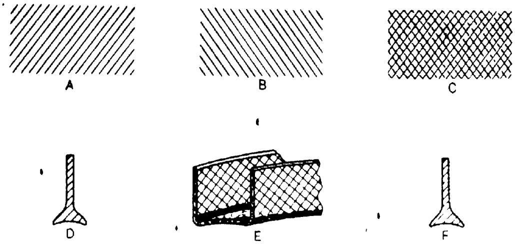


Fig. 2

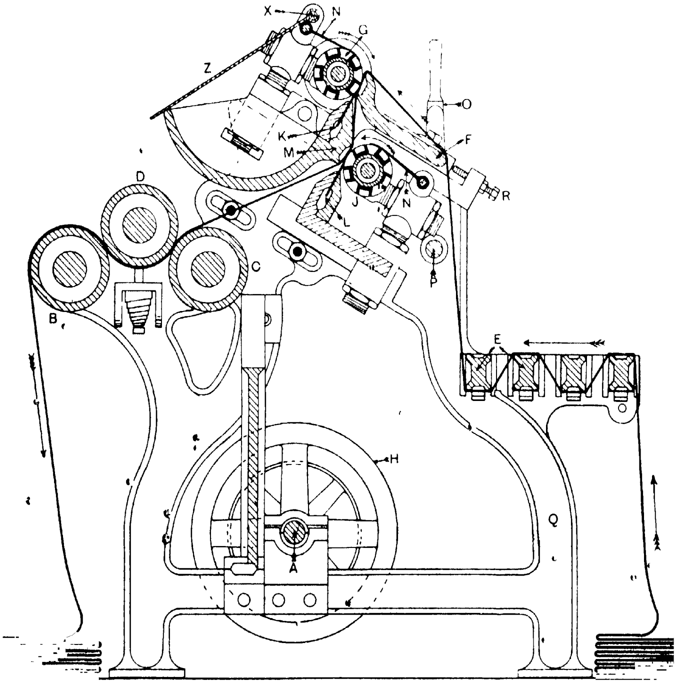


Fig. 3.

the makers claim that it will crop as successfully in one run through as the ordinary quadruple machine, and that if the finishing spirals

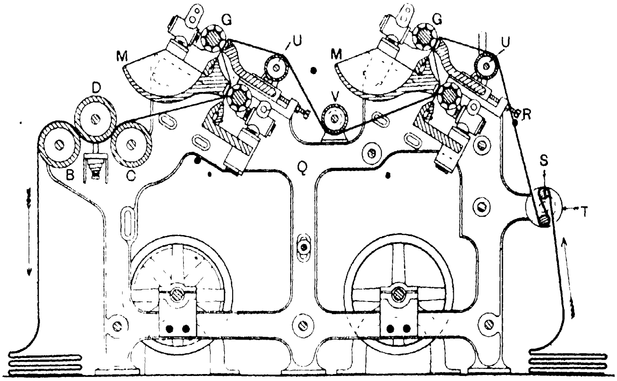


Fig. 4.

of a quadruple machine are of the over-cut type, results are obtained in one operation which are equal to twice cropping in the ordinary quadruple machine. Each spiral, with its clothing of blades, is arranged to revolve against a fixed blade about three inches broad, $\frac{1}{16}$ in. thick, and at least equal to the length occupied by the spirals. One side of this blade is concaved near one edge, and along its entire length, to the circle described by the rotating spiral. This concavity or channel is obtained by the application of oil and emery powder to the spiral while the latter is rotated at a much reduced speed in the reverse direction to the normal. In this manner the spiral grinds out a hollow in the fixed blade—this hollow portion, therefore, coincides with the path of the periphery of the spiral. The edge of the blade must not be ground down too much, otherwise the thin edge will be unable to resist the pressure of the spiral when it is rotated in the normal or cutting direction for the purpose of cropping. Over-grinding, besides thinning the edge of the

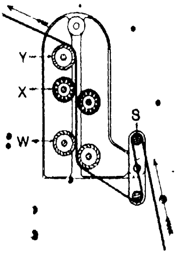


Fig. 5.

blade, results in deficient cropping, and necessitates an early regrinding.

Fig. 3 shows a sectional elevation of a double spiral cropper made by Messrs Urquhart, Lindsay & Co., Ltd., Dundee. The driving shaft A runs at about 320 revs. per minute, and by suitable gearing, not shown in the figure, rotates the pulling and delivery rollers B and C at a surface speed of about 10 yards per minute. The surface speed of these rollers determines the speed of the cloth since the pressing roller D, by its own weight and by suitable spring pressure, exerts sufficient force to enable the cloth to be gripped by the three rollers and to be pulled or drawn through the machine. The pressing roller D is covered with cloth in order to increase its power of gripping,

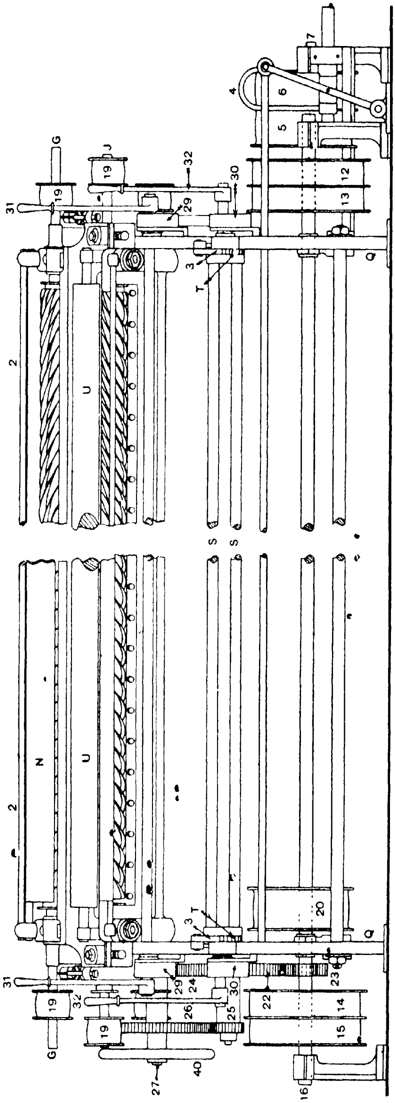


Fig. 6.

and to prevent any slip; roller C is often covered also for the same purpose. The direction taken by the cloth is clearly shown by the arrows, and its path by the heavy dark line.

The cloth is first "railed" or tensioned by causing it to pass over and under a series of rails, four being shown at E in the figure: it then passes over the heavy adjustable guide-plate F, and immediately meets the first or top spiral G, which is driven by an open belt from the pulley H, in the direction indicated. The cloth then approaches the second, or bottom spiral J, towards which it is suitably guided by projections on the back of the holder M of the fixed blade K, and is finally drawn out of the machine by the three rollers. The second spiral J is rotated in the direction shown by means of a crossed belt from pulley H, and the two fixed blades K and L are held firmly in their respective positions as shown.

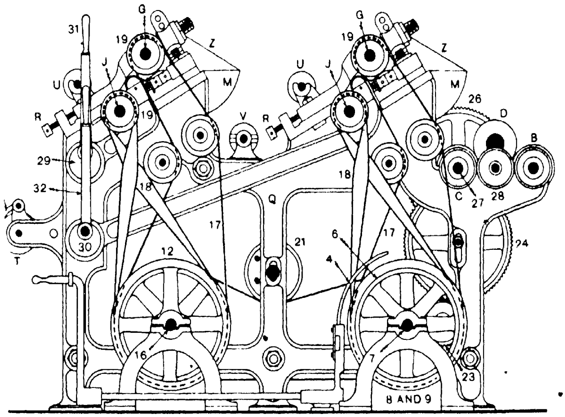


Fig. 7.

As the cloth passes in front of each spiral, the projecting fibres are caught between the fixed and moving blades, and shorn off the fabric as the spirals revolve. Since the cloth is in close contact with the spirals, it is absolutely essential that it should be free from lumps, folds, creases, or any slackness, otherwise the moving blades may remove parts of the cloth in addition to the loose fibres. The guide-plate F and the holder M are hollowed out immediately opposite their respective spirals in order that any thick part of the cloth may yield a little during its passage in front of the spirals. In spite of this precaution, however, the pieces are often damaged by the spirals; when this occurs the holes are repaired by darning. Some firms have a stop-motion to place the belt on the loose pulley when any thick places appear. Guide-plate F and holder M are both adjustable, so that different thicknesses of cloth may be equally satisfactorily cropped. The methods of adjusting F and M are similar in principle, although only that for F is shown; the parts consist of bolts and lock nuts R in projecting parts of the frames Q.

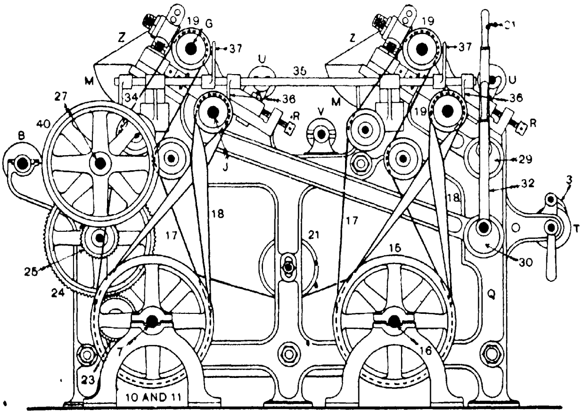


Fig. 8.

Each spiral is provided with means of vertical adjustment, and also with regard to the pressure on the fixed blade. The spirals are kept lubricated by well-oiled leathers N which rest upon them. The short projecting fibres, known technically as "caddis," which are removed from the cloth by the top spiral, are caught in the semi-circular continuation of the holder M, while those from the lower spiral fall to the floor unless special apparatus is provided to carry them away as they are cut off the cloth. Tin covers Z, fulcrumed at X, prevent the caddis from escaping from the holder M.

By means of a handle O, and an eccentric on shaft P, the holder M and the top spiral G may be pushed upwards and outwards to

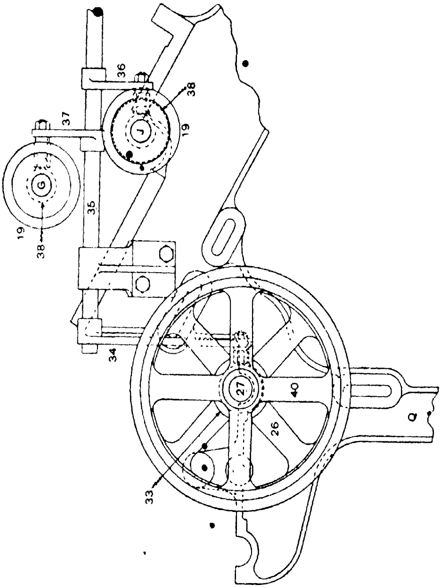


Fig. 10.

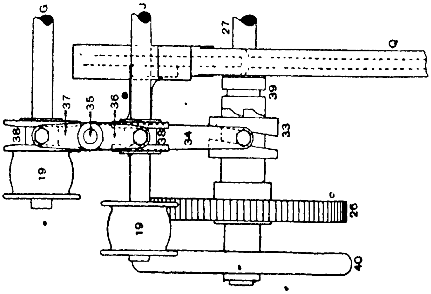


Fig. 9.

create a gap sufficiently wide for the safe passage of the sewn ends of the different pieces.

Figs. 4 to 8 show different views of a wide quadruple cropper, also made by Messrs Urquhart, Lindsay and Co., Ltd ; the spirals in this machine are driven at both ends. From Fig. 4, which is a sectional elevation, it will be seen that the quadruple machine is simply an extension of the double cropper illustrated in Fig. 3, the extension being a duplication of the spirals and knives, and the introduction of suitable rollers U and V to guide the cloth properly through the machine. A slightly different method of railing the cloth, however, is shown in this figure. The ordinary tension bars,

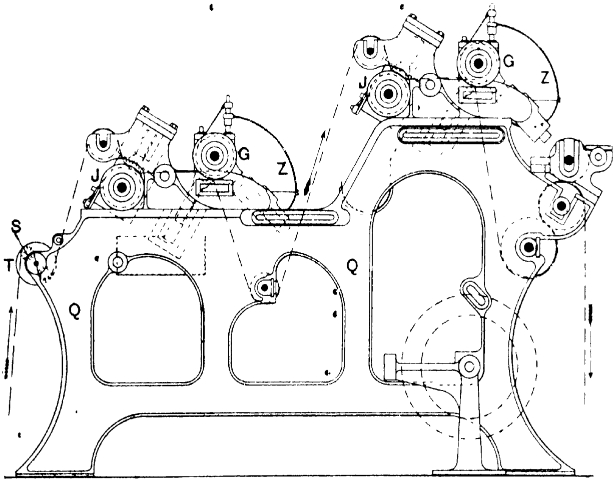


Fig. 11.

such as those shown at E in Fig. 3, are supplanted by an improved apparatus which consists of two heavy, stiff iron rods or tubes S, supported diametrically opposite each other in two circular head-pieces or discs T ; these discs are centred in projecting parts of the two end frames Q. The cloth is passed between the tension bars which are then rotated, by means of a handle, into the most suitable position for the degree of tension required. The bars are then held there by the fixed pawls 3 and teeth in the discs T (see Figs. 6, 7 and 8). Scrubbers W (Fig. 5) and brushes X, for rough cleaning the surface of the cloth, and for effectively raising the fibres, are sometimes attached to this machine. The scrubbers consist of rough ropes wound tightly round a wooden beam of the necessary length, and the cloth, after being tensioned by the rails S, passes between these scrubbers, then between the brushes, and finally over the guide roller Y.

Fig. 6 is a front elevation of the quadruple cropper, and, when taken in conjunction with Figs. 7 and 8, which are elevations of opposite ends, gives a good idea of the general appearance of the machine. In Fig. 6 the spirals are shown partly covered and partly uncovered. The main drive is shown on the right with the belt fork 4 in the off position. The fast and loose pulleys 5 and 6 are on shaft 7, which also carries four pulleys 8, 9, 10 and 11 for the spirals near the delivery side (see all views). A similar set of pulleys 12, 13, 14, and 15 on shaft 16 drives the spirals near the feed side. It will be seen that straight belts 17 drive the upper spirals G, while crossed belts 18 drive the lower spirals J, from flanged pulleys 19 on the ends of the shafts of the spirals.

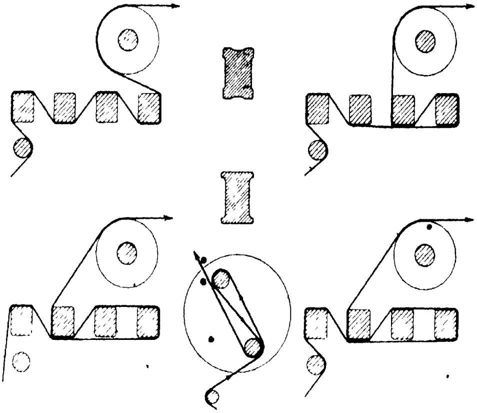


Fig. 12.

The shaft 16 receives its motion from a broad flanged pulley 20 on shaft 7 (Fig. 5), and, in order to keep the belt at the proper tension, a tension pulley 21 is provided (Figs. 7 and 8). The gearing for the delivery rollers is seen to the left in Figs. 6 and 8, and to the right in Fig. 7. A pinion 22 on shaft 7 drives wheel 23, and the latter conveys the motion to wheel 24. Compounded with wheel 24 is a pinion 25, which drives the wheel 26 on the shaft 27 of roller C. Roller C drives roller B by the intermediate wheel 28. Two eccentrics 29 and 30, operated by hand levers 31 and 32, provide means for creating a gap between the spirals and the guide-plates or holders, for enabling a fresh piece to be entered, or for the increased thickness when the end of one piece is sewn to or connected with the beginning of another piece.

In addition to a rotary movement, each spiral has an end-long movement of about $\frac{7}{16}$ in. along the fixed blade; this prevents the formation of ridges in the latter, and also keeps both spirals and fixed blades in better order. This desirable motion is imparted to the spirals by a cam 33, on shaft 27 (see Figs. 9 and 10), and working in conjunction with the lever or arm 34, fixed to shaft 35. Anti-friction bowls on the ends of levers 36 and 37 enter into the grooved discs 38, and it is clear that when cam 33 oscillates arm 34 and shaft 35, the desired end-long movement to spirals G and J will result.

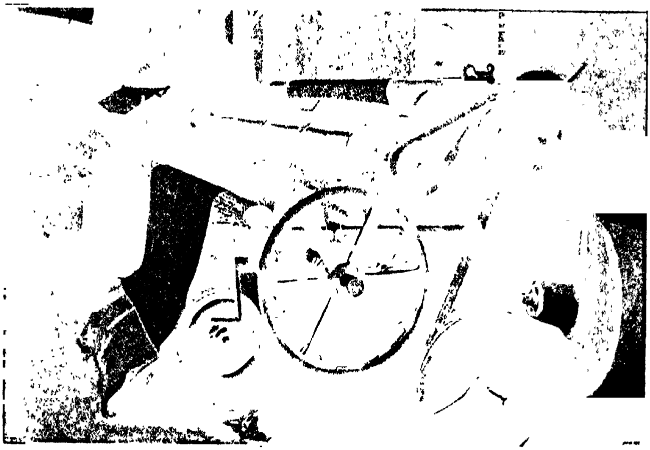


Fig. 13.

The grooved cam 33 and the gear wheel T are compounded, but are loose upon the shaft 27. When these are in contact with the clutch 39, which is connected with shaft 27 by means of a key and keyway, all move together and the cloth is delivered by the machine. When, however, the clutch 39 is withdrawn, the shaft 27 ceases to rotate. This movement is very desirable, for it is often necessary to actuate the delivery rollers by hand in order to pull damaged parts of cloth through the machine. When parts 33 and 39 are disconnected, the shaft 27, and therefore the delivery rollers C, D, and B, may be rotated freely in either direction by the hand-wheel 40 and quite independently of the further connections of the machine.

Fig 14.

It is, of course, understood that the spirals, if permitted to run, must never be in close contact with the cloth when such operations take place. The safer proceeding is to stop the spirals entirely by putting the driving belt on the loose pulley 6 (Fig. 8).

Fig. 11 shows the general arrangement of, and the path of the cloth through, a quadruple machine made by Messrs A. F. Craig and Co., Paisley. This firm usually arranges for one belt to drive a set of two spirals. The belt is tight when the spirals are required to cut the cloth, but the latter cease to rotate, in virtue of the belt being slackened, when the gap is formed for the passage of the ends of the pieces.

The speed of the cloth through each machine is about the same, the surface speed of the delivery rollers varying between nine and ten yards per minute. The spirals make from 1050 to 1100 revs. per min., a number which, with ten blades per spiral, represents approximately 26 to 30 cutting contacts per inch of cloth passed through the machine.

$$\frac{\text{revs. of spiral} \times \text{number of blades}}{\text{delivery in yds.} \times 36 \text{ ins. per yard}} = \text{cutting contacts per inch.}$$

The cutting contacts are naturally doubled in the case of a quadruple cropper.

Fig. 12 shows several types of rails to be found on cropping machines; it also serves to illustrate different methods of railing the cloth for the purpose of obtaining the correct degree of tension. In general, a heavy, stiff cloth requires to be more heavily railed than a lighter one, but the proper method of railing for any particular cloth can only be determined by experience or by trial.

A good idea of the general structure of a quadruple cropper will be formed from Fig. 13, which shows the delivery sides of two machines—the delivery rollers are arranged in different ways. Fig. 14 illustrates a row of cropping machines fitted with Messrs Matthews & Yates', Ltd. Cyclone Dust Collecting apparatus. Instead of the dust being allowed to fall on to the floor as mentioned in connection with Fig. 3, it is drawn through the large pipes and the main duct to a convenient place in which is situated an exhauster and separator. Fig. 14 also illustrates the method of utilising the full width of the machine when narrow goods have to be cropped; four narrow pieces are sometimes passed through the machine at the same time.

# CHAPTER III

## DAMPING

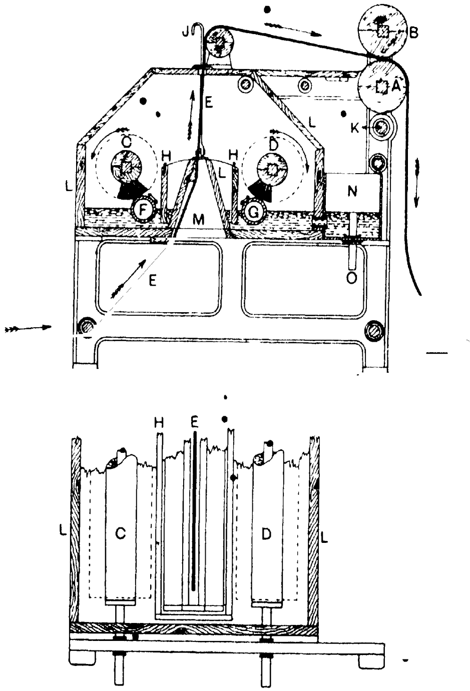
DAMPING.—All jute and linen fabrics, with at least very few exceptions, are more or less mechanically damped previous to the actual finishing operations. Flax and jute, like other fibres, have a certain natural affinity for water, but this hygroscopic property does not of itself induce a proportion of moisture in the fabric sufficient for its successful treatment during the finishing process. It is therefore necessary to add to this natural quantity of water an additional amount by mechanical means, in order that the ultimate firmness and crispness of the finished article may be assured. A considerable amount of heat is generated in various ways during the actual operation of finishing, and if the cloth were treated while holding only its natural proportion of moisture, the evaporation would be carried to such an extent that the fibre would approach, and perhaps reach, an absolutely dry condition. Cloth, therefore, which has not been damped, or which has been allowed to lie too long before finishing, and so become comparatively dry again, has a distinct tendency to become limp and flabby. The length of time during which pieces should remain in the damp condition will, of course, vary with the class of fabric, but in all cases sufficient time should be allowed to permit of the moisture penetrating the fabric uniformly. Six to eight hours' time may be sufficient for light and medium hessians, but heavy sackings and similar fabrics require a longer interval, and a common and satisfactory practice for these goods is to damp them towards night, and then finish them next day. This arrangement should be particularly attended to in the case of striped goods, since, if this class of fabric be finished too soon after damping, the coloured yarns may " bleed," and thus cause considerable discoloration of the adjacent portions of the cloth. Excessive damping should also be guarded against for the same reason.

The weight of water added per square yard of cloth must also vary with the weight of the fabric, and with the type of finish intended. An addition of about 5 to 6 per cent. in weight is, however, found to be suitable for a wide range of fabrics, with about 1 to 2 per cent. less in the case of goods intended for mangling, or for any calender finish in which little heat is to be used in the steam cylinders. Since the speed of a damping machine is constant, all goods are run through at the same rate; it is therefore obvious that some provision must be made for regulating the quantity of water added. This is provided for in most machines, and the required degree of moisture may generally be obtained by running the piece once through the machine. For extra heavy damps, however, it is considered much more satisfactory to reduce the flow of water and to run the piece through twice. This method ensures a more equal distribution of moisture in the fibres.

In general, linen fabrics require less damping than jute goods, and a damping machine provided with only one brush is usually found to be sufficient for the purpose, and even if there are two brushes or their equivalents, the piece is almost invariably damped only on one side. In the case of bleached damasks, which are starched and dried after bleaching, it is sometimes possible to remove them from the drying machine while they are still in a semi-damp condition; further damping before finishing is then unnecessary.

There are several types of damping machines, the two most popular being termed the " brush " and the " spray." The former is the older type of machine, and is probably the more useful where a wide variety of fabrics has to be treated, and particularly so if it is necessary at any time to add a slight mixture of starch or other weighting or deliquescent ingredient. The spray machine, on the other hand, has its own peculiar advantages, and in some districts it is gradually displacing the brush method for pure water damping. It is, however, almost restricted to this class of work. It is also found to give very satisfactory results with wide goods, for the treatment of which the brush machine is found to be somewhat deficient.

The brush damping machine for jute goods, as made by Messrs Charles Parker, Sons and Co., Dundee, is shown in sectional elevation and part plan (Figs. 15 and 16). Its chief parts are the following:—Two heavy pulling and delivery rollers A and B, the function of which is to draw the cloth rapidly through the machine. Roller A is positively driven by belt and gearing, while roller B is rotated by frictional contact with the cloth and roller A. The two brushes C and D, revolving in the direction as shown by arrows, one on each side of the path of the cloth E, are in close contact with the two brass feeding rollers F and G. These latter revolve in the same direction as the brushes, and, being half-immersed in the water, supply a sufficient quantity of it to the brushes. The bristles sweep the periphery of the brass rollers, and so remove the



Figs. 15 and 16.

water which flies off tangentially and impinges against both sides of the cloth E. In the machine illustrated the brushes C and D are belt-driven from the main shaft K of the machine, while rollers F and G are rotated in the same direction by suitable gearing from the arbors of C and D.

The wooden mask or float-box H may be raised or lowered by the hook J, and supported at any desired height so as to shield the cloth more or less from the action of the brush, and therefore procure a decreased or an increased percentage of damp respectively.

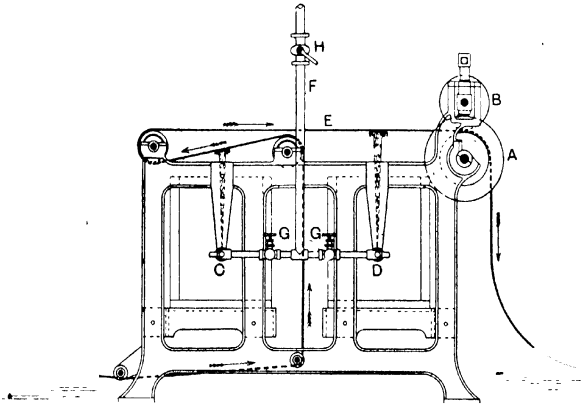


Fig. 17.

All the parts are enclosed in a substantial and tightly-fitted wooden casing L, in which a central opening M is left for the passage of the cloth. This central opening M stops short at each end (see Fig. 16) in order that the water may have free circulation round these ends to both feeding rollers. A continuous water supply is obtained by the action of a ball-cock in cistern N; the ball-cock is connected in the usual way to the main water pipe, while the cistern communicates with the brush-box as shown. An overflow pipe O is connected by its lower end to an adjacent drain in case the ball-cock should at any time fail to act. At the delivery side of the machine, but not shown in the illustration, is a plaiting-down apparatus, or what is often termed a "faking" board, the function of which is to throw the cloth into semi-regular folds. After having been damped, the piece is rolled up tightly in its own end sheet, and then laid aside to permit the damp thoroughly to penetrate the fabric.

In Messrs Charles Parker, Sons and Co.'s spray damper, an end elevation of which is shown in Fig. 17, the pulling and delivery rollers A and B are again provided and driven in a similar manner to the above, but the damping mechanism consists of two perforated copper spray pipes C and D, which pass across the machine underneath the cloth E, and are connected to a supply pipe F which communicates with a cistern above having about 15ft. head of pressure. Each spray pipe is provided with a valve G by which the quantity of moisture imparted to the cloth may be regulated, while a further valve H on the supply pipe from the cistern automatically renews and cuts off the flow with the starting and the stopping of the machine. An examination of the figure shows that the passage of the cloth E through the machine is so arranged that the vertical sprays of water act on opposite sides of the cloth. Pure water should always be used in the spray damper, as otherwise the small perforations in the pipes C and D would become choked. In cases where there is a scarcity of pure water, or where, in consequence of suspended matter, the water has to be filtered, the superfluous water may fall into a tank underneath the sprays, and be pumped back into the cistern above for future use. Although pure water is essential for the spray damper, the addition of deliquescent and weighting agents is admissible, and is occasionally resorted to, where the brush damper is in use.

Damping machines may, of course, be arranged to run at various speeds, but the speed of any one machine is seldom altered. For light fabrics, and light damping, the speed may reach 150 to 160 yds. per minute, while for heavier goods a speed of 125 to 130 yds. per minute might be more suitable.

# CHAPTER IV

## CALENDERING AND CHESTING

ALTHOUGH the term finishing may be used in a general sense to include all the processes to which jute and linen fabrics are submitted from the time they are woven until they are ready for delivery, it is also used, especially for jute fabrics, with particular reference to the more immediate processes of calendering, chesting, or mangling, since the characteristic appearance or finish of these cloths depends directly and almost exclusively on one or other of these three operations. All three processes are used for linen as well, but, in addition, it is necessary to mention the equally important and essential operations of bleaching and beetling. Indeed, the beautiful effects which one admires in the finer classes of linen are obtained, first by bleaching the cloth to the proper degree of whiteness, and then by finishing it by means of beetling and calendering machines. Those fabrics, however, which are made from bleached yarns are, in general, treated like jute cloths to a simple process of calendering, chesting, or mangling.

The fundamental principle underlying all these finishing operations seems to depend upon the fact that cellulose in general, and therefore all vegetable fibres, retains the form and appearance which is imparted to it while in a moist or damp condition, provided this form is fixed by the immediate drying of the fabric. Paper is a familiar and typical material which shows this behaviour of the products of vegetable matter. It readily re-assumes a pulp-like condition when an excess of moisture is added, much in the same way as a cloth, made from vegetable fibres, loses almost all trace of its original finish when it is washed. It would appear, therefore, that for the successful finish of a cloth made from yarns of vegetable fibres, the following operations and conditions are, in general, essential:—

1. A sufficient percentage of water in the cloth.
2. Means of imparting different pressures for the purpose of flattening the yarns in the fabric to the proper degree.
3. Sufficient heat rapidly to evaporate the excess of moisture added in the damping process.

Provision for the first of the above requirements is made in the damping machines, which have already been described, while the remainder is provided for in the various calenders, mangles, and beetling machines which form the chief part of the equipment of modern finishing departments for the treatment of jute and linen fabrics.

The introduction of heavy finishing machinery is of comparatively recent date, but it has done much to beautify the fabrics, and also to make it possible to impart a satisfactory surface to light fabrics—a condition which was impossible before these machines were introduced. The old hand-loom weaver in many cases literally made the cloth in the loom, but modern methods depend a great deal upon the finishing department. It must, of course, be understood that enormous quantities of cloth made in the modern power-looms are, in many cases, better than any hand-loom cloth; on the other hand, large quantities are now made very light indeed, but this heavy machinery has made it possible to finish these cloths in such a way as to make them perfectly satisfactory for the uses to which they are put.

The hand-loom weaver adopted no artificial means to make his cloth firm, neither did he resort to any system of loading or filling to add weight to his fabric. It is interesting to know, however, that he used very crude instruments, termed "Smoothing Stones," or "Weavers' Stones," in his attempt to put a skin or finish on his cloth, and that these crude attempts have their sequel in the ponderous finishing machinery of the present day.

THE CALENDER.—Figs. 18 and 19 show respectively end and back elevations of a modern heavy five-bowl calender as made by Messrs Robertson and Orchar, Limited, Dundee, while Fig. 20 is an illustration of the front of the machine, and also of the opposite ends to those shown in Fig. 18. The great weight of the machine, and the heavy character of the work which it has to perform, render a firm foundation an absolute necessity; this foundation usually consists of a specially prepared bed of concrete from 12 to 14in. deep. Calenders vary in width, according to the class of work for which they are intended, and their designation is in terms of the number of bowls, and of the width or length of such bowls. The width of the bowls may be anything from, say, 50 to 170in., but it is usually one or other of a few standard widths between the above extremes, such width depending upon the variety of fabrics to be finished. A very common standard width is 90in.; this is very suitable for finishing two 40in. cloths at the same time, or one piece of any wider width up to about 84in., while three or more narrow crashes may be calendered at the same time. When two or more narrow width cloths are run through together, it is, of course, necessary to guide them individually at the first calender "rail" in order to prevent overlapping on the bowls. These guides are shown on the first rail in Fig. 20.

The two end frames A, which are essentially heavy and substantial, are securely bound together, and are provided with bearings and guide slots for the arbors of the five finishing bowls. These parts, together with the forward and reverse driving gear, and the system of weights and levers for the application of the necessary pressure, constitute the chief features of all modern machines. Since the pressure applied may reach a maximum of about 5½cwt. per inch or width, or a total pressure of 90in.×5½cwt.=495cwt., say, 25tons on a 90in. calender, it is obvious that the bearings of the bottom or iron bowl B must be very substantial. This bowl B, which is 24in. in diameter, and is shown in section in Fig. 19, consists of a cast-iron shell of considerable thickness, into the centre of which a heavy steel arbor is pressed by hydraulics. Bowl C is termed the bottom paper bowl because of its position with respect to bowl G, and on account of the material of which it is made. Thin paper, in the form of rings, is compressed upon a steel shaft by heavy hydraulic pressure. Thousands of such rings are used for one bowl, the weight of paper alone being about 20lb. per inch of width. Great care is taken to have a good quality of paper, and to see that it is perfectly dry before it is used. The work of compressing the rings is done in stages—about six or seven for a 90in. bowl—and at the end of each stage the pressure is kept up for about 20 to 22 hours. When the bowl is finished it is taken to the lathe, where the rings are turned down until a perfectly cylindrical bowl of about 27in. diameter is made. Constant work

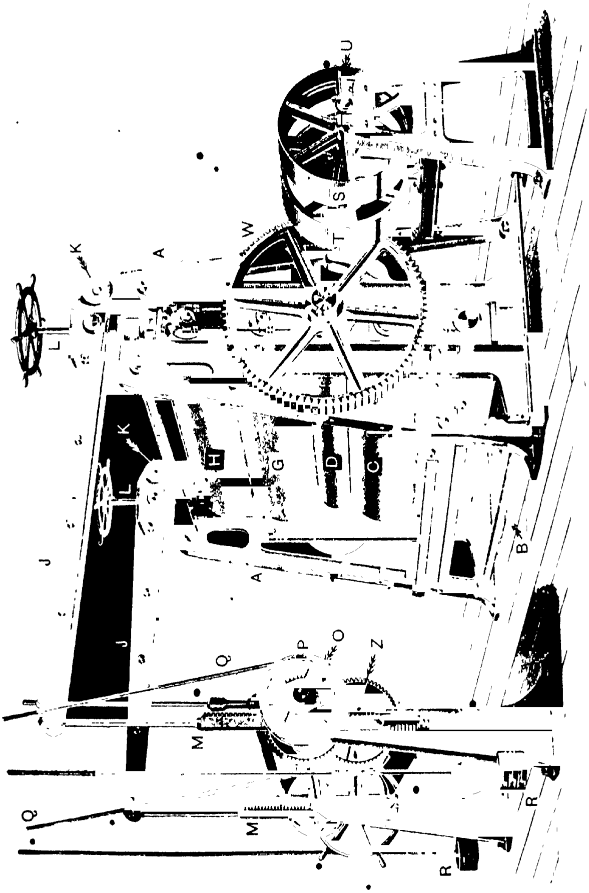


Fig. 20.

wears the surface and makes it untrue, but this defect may be, and is, remedied by turning and trimming up time after time until a minimum diameter of about 18in. is reached. It is advisable from time to time to change the position of entering the cloths, so that this wear and tear may not occur in the same place, while those parts of the bowls which come in contact with the outside selvages of the cloth are often scraped to prevent the selvages from breaking.

The central bowl D, or the steam cylinder, is naturally hollow, and is provided with a steam inlet pipe E (Fig. 19), which admits steam at about 30lb. pressure for heating purposes. The condensed steam is discharged through the syphon outlet pipe F, which is in turn connected with a Royle's steam trap to prevent waste of live steam. The above is the most general method of applying heat to the cylinder D, and, although greater pressures of steam can be obtained, the above-mentioned provides sufficient heat units for most purposes. When very high temperatures are required, the heating is often done by coal-gas and air. This method of heating is also applied for lower temperatures when steam is not available. In a few exceptional cases red-hot bars of iron are introduced into the cylinder; this style is most antiquated and unsatisfactory, since it is quite impossible to keep a constant heat. Different opinions exist as to the relative values of the methods of heating by steam and by coal-gas and air. Some claim that the finish is dull when obtained by steam, while gas and air give a brighter finish. Such difference is probably due more to the difference in temperature and to the difference in the relative speeds of the bowls in the two cases than to the particular method of applying the heat. If the question of heating turns only on the method, that of steam heating is undoubtedly safer, for it is not unusual to have explosions when the mixture of gas and air is not in the proper proportions.

The paper bowl G and the iron bowl H are in all respects similar to bowls C and B respectively. It will thus be seen that the arrangement of the bowls is one of iron and one of paper throughout, so that at no place are there two bowls of the same material in direct contact. Bowls of plane-tree wood are sometimes substituted for the paper bowls C and G in those calenders which are used for the finishing of bleached and beetled fabrics. The five-bowl calender is employed more than any other type, although calenders with from three to eight or nine bowls are utilised for specific purposes.

When eight bowls are used there are two steam cylinders, and the alternate order of metallic and paper is departed from in order that both sides of the cloth may come in contact with a hot cylinder. The arrangement of the bowls for such a purpose is as follows:

No. 1. Bottom iron bowl.
,, 2. First paper bowl.
,, 3. First steam cylinder.
,, 4. Second paper bowl.
,, 5. Third paper bowl.
,, 6 Second steam cylinder.
,, 7. Top paper bowl for heavy chesting, etc.
,, 8. Top iron bowl for light chesting, etc.

The three-bowl calenders are usually for the finishing of light fabrics, and for light types of finish to heavy cloths such as sackings. They are made with and without steam cylinders, but, although a hot cylinder imparts a better finish than a cold one, the latter is quite satisfactory for many classes of cloth where no glazing is required. The pressure in many of the three-bowl calenders is obtained by means of screws alone; on the other hand, many three-bowl calenders are provided with a system of levers and weights which is similar to that illustrated in Figs. 18 to 20.

The deadweight of the bowls in a 90in. five-bowl calender amounts to about six tons; in addition to this weight, pressure may be applied by means of levers J, which, fulcrumed at K, act on the iron bowl through rods L. A rack rod M (Figs. 18 and 20) is suspended from the extremity of each lever J, and is kept in gear with a toothed pinion N, which is keyed to shaft O. Keyed fast to the same shaft is a flanged pulley P, to which is fixed one end of a chain or a belt Q. The belt, which is three or four inches wide, encircles the pulley, and the loose end is passed over a guide pulley near the roof, and then brought down within a few feet of the floor. To this end of the belt a weight rod is attached on which weights R, of about 40lb. each, may be placed to give the necessary pressure. Since the mechanical advantage due to lever J is about 25 to 2, and that due to pulley P and pinion N about 4 to 1, it follows that the addition of one 40lb. weight R results in an additional pressure about 17 to 18cwt. being applied to bowl H, and therefore to e cloth which is between the bowls.

$$40\text{lb.} \times \frac{25}{2} \times \frac{4}{1} = 2000\text{lb., or } 17\tfrac{6}{7}\text{cwt.}$$

When setting the calender it is necessary to raise the weights from 12in. to 15in. from the lowest point, in order to make re that the levers J shall not come in contact with any part of e framework.

The calender is driven by means of two pairs of cone friction illeys, S and $S^1$, and T and $T^1$ (Figs. 19 and 20), one or other .ir of which acts for the time being as the driving medium. ıe outer pulleys S and T, both of which are loose on the shaft are driven from the main shaft—one by a crossed belt, .d the other by an open belt. They thus run continuously while e engine is in motion and the belts intact. The inner pulleys and $T^1$ (Fig. 19) form one piece, which is capable of lateral movement on the central shaft on account of a feather and keyway nnection. The central part of this piece is grooved, and through .is groove the whole piece is controlled by means of a clutch-fork tuated at the upper end of a vertical rod keyed to the shaft of the t-on handle. When this handle is vertical, as shown in Fig. 19, )th friction cones are out of gear, and the calender remains out action. A movement of the handle in either direction, however, .uses the compounded cones $S^1$ and $T^1$ to engage with either S or T, ıd to rotate the shaft U in the corresponding direction. Between ılley T and the framework is a pinion V, which is fixed to shaft U, ıd which communicates motion to the large wheel W. The latter keyed on the end of the steam cylinder D, the surface speed of hich is from 20 to 25yds. per minute for ordinary work. The ırface speed of D determines the speed of the other bowls, and so that of the cloth which passes through the machine. The ecessary levers, etc., by which the attendant regulates the position the driving cones are clearly shown in the figures.

A stripping roller X (Figs. 18 and 19), is an essential part after ıe close of the finishing operation termed "chesting." This roller driven by an independent but simple cone friction drive at Y, hich is placed in and out of gear by the lever and clutch shown in Fig. 19. Roller X is easily lifted out of its bearings, and this is done immediately it has unwound or stripped the piece from the calender bowl. Roller X and the cloth, both of which are clearly seen in Fig. 21—a view of a row of calenders—are now taken to the measuring machine, where the cloth is measured as it is pulled off the roller. This is the general way, but in some special cases the stripping roller is dispensed with, and the measuring operation performed on the spot. In such cases a measuring machine is placed immediately behind each calender, and measures and strips the cloth directly from the chesting bowl.

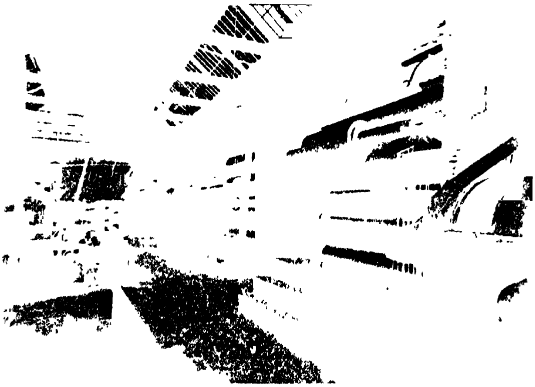


Fig. 21.

In the process of chesting, the whole length of cloth is wrapped round either bowl H or bowl G. It is usually wrapped on H, and, in order to permit of its being stripped, this bowl, with the cloth upon it, must be raised clear of the bowl immediately underneath. To accomplish this, further gearing is provided on shafts O and Z (Figs. 18 and 20). A belt-driven pulley, not shown in Fig. 18, but visible in Fig. 22, revolves loosely on shaft O. Compounded with this pulley is a small pinion which gears with and drives a toothed wheel 2 keyed on the brake shaft Z (Fig. 18). Another pinion 3 on this shaft gears in turn with and drives a wheel 4 keyed on shaft O, on which the rack pinion is keyed. This compound gearing permits of rack rods M and levers J being lifted at will. Rods L rise with levers J; they also raise the bearing blocks of bowl H. The movement is regulated and limited by the adjustment of a collar or ball at the top of rod 5. The lever J, in its upward movement, comes in contact with this ball, and by means of it raises the rod 5. As the latter rises it moves the belt fork and belt on to the loose pulley, and thus provides an automatic stop motion. When the chesting bowl has been raised, it is kept in position by a pawl acting on a ratchet wheel 6, situated on shaft Z. Handwheel 7 enables the attendant to complete the raising of the bowl, and also to lift it sufficiently to release the catch of the ratchet wheel when the bowl requires to be lowered after it has been stripped. The bowl is governed in its descent by means of the brake 8 and the handle 9.

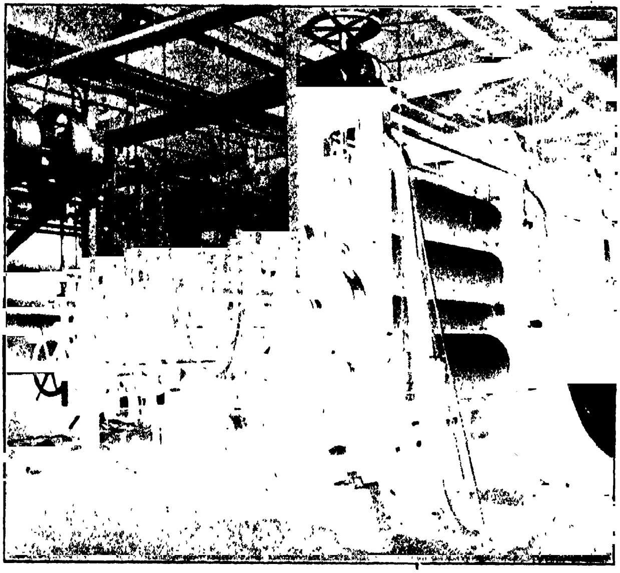


Fig. 22.

If chesting has taken place with the cloth on the top paper bowl

G, it is quite evident that, before the cloth can be stripped, bowl H must first be lifted clear of G before the latter begins to leave the steam cylinder D. Fig. 18 shows that rods 10 connect the bearing blocks of bowls H and G, and that the adjustable nuts 11 can be arranged to permit of bowl H rising a considerable distance before they begin to act upon the bearing blocks of bowl G. The cloth is wound on bowl H for light and ordinary chesting, but the heavy chest finish is usually performed with the cloth on bowl G. All the weights R (Figs. 18 and 20) are used for the heaviest chest finish, but even in this case the general arrangement of weights and levers, and the method of applying power to racks M through the medium of heavy helical springs 12, ensure a high degree of elasticity and freedom from shocks—conditions which are most desirable in the working of heavy machinery of this character. For a very light finish, where little pressure is desired, the addition of weights R may be caused to act in a negative manner by attaching belt Q round pulley P in the reverse direction to that shown in Fig. 18. When arranged in this way, the tendency of the weights is to lift rack M, levers J, rod L, and therefore bowl H, and thus decrease the pressure applied to the cloth; this arrangement of parts produces the so-called "round-thread" finish. It will thus be seen that a very wide range of pressures may be obtained.

The time during which a piece undergoes chesting depends upon the style of finish, and upon the cloth. Some cloths are kept on the bowl about three minutes, while others remain on only for two minutes. The cloth may be kept on six, seven, or eight minutes if the direction of motion be alternated. If the bowl be run in one direction only for such a period, the cloth is continually getting tighter and is being stretched on the bowl; consequently there is a tendency to burst or break the yarns. Running the bowl alternately forwards and backwards minimises this danger. A very common finish is termed double chesting; this is simply repeating the operation. In all cases it is very essential that the selvages of the cloth should not be thicker than the rest of the piece, although it is difficult to obtain this desirable feature always. Thick selvages result in unsatisfactory finishing; in addition, parts of the selvage are liable to be damaged, while it is not unusual to find the calender wedged when the selvage at one side is thicker than the other.

When the calender is intended to be used for the purpose of glazing, bowls D and B are geared together by an intermediate wheel 13 (Fig. 18), so that the surface speed of B is reduced. This change reduces the speed of the cloth; but, since the surface speed of the steam cylinder remains as before, it is clear that it must slide or slip over the surface of the fabric. This slipping is measured by the difference in the surface speeds of the two bowls, and since it occurs under heavy pressure, and since the cylinder D is heated, it follows that a highly glazed or polished surface is produced on that side of the cloth which is next the steam cylinder. If both sides require glazing, the cloth must be run through the calender a second time with the other side presented to the action of the cylinder, unless the calender is provided with two steam cylinders, and so arranged that the face of the cloth is glazed by one cylinder and the back by the other. From this it will be seen that the glaze or polish depends upon the relative speeds of the hot and cold bowls, and upon the pressure. The operation is, indeed, very similar to, but on a much larger scale than, ordinary ironing, in which case the cold surface, usually a table, has no motion, while the difference between it and the iron, coupled with the heat and pressure of the latter, produce the much-admired surfaces of different kinds of laundered articles.

The speeds of the bowls D and B in any one calender are invariably in the same ratio, but this ratio may be, within limits, of any value that the finisher may desire to order. Thus the gearing between D and B may be so arranged that the surface speed of bowl D (which varies, in different finishing departments, from 20 to 25yds. per minute, but which is constant for all classes of work in the same place) may exceed the cloth delivery by any single value between 30 and 50 per cent. The quality of the glaze improves with higher temperatures, and also with increased differences in the speeds of the two bowls; but it is quite clear that the tendency to damage the cloth is increased at the same time. For many classes of cloth the operation of glazing is a necessity, but from the very nature of the movement it is evident that a very heavy strain is placed upon the whole of the calender frame, and the process also results in excessive wear of the finishing bowls.

The rails by which the cloth is held in tension are shown in position at 14 in Fig. 18, and also in Fig. 20, and we need hardly say that these rails should be quite stable, and absolutely parallel to the calender bowls. The cloth is shown passed alternately over and under the rails in Fig. 18, but this is only one of a great number of different methods of railing. No absolutely general rule is observed in the method of railing; each workman has usually his own particular fancy, but, in general, light goods and those goods intended for light finishes must be railed more lightly than heavy goods or those intended for a heavy finish. The question of width is also a very important factor, and must be carefully considered, since a "heavy rail" in the calender may reduce the width of the cloth considerably under that desired for the finished state. In all cases, but more particularly where there is only a small margin to draw in, the cloth should be placed in the calender, so that any curve made by the weft in weaving may be reversed or removed. If this point be observed, the cloth will allow more for shrinkage in width, and, in addition, a better cloth will result, since the weft will be drawn into approximately straight lines.

The contraction in width due to finishing jute and linen fabrics is always accompanied by an increase in the length of the piece, but the two changes do not bear any well-defined relation. The type or style of finish desired is also a controlling factor in the ultimate or finished width and length of the piece. In the process of mangling, during which the cloth is not under a severe tensile strain, there is a slight tendency to increase the width and to decrease the length of the cloth. On this account goods for mangle finish are not so wide in the loom as are those for calender finish. For example, a 40in. hessian may measure 43 to 43½in. in the reed for chest and calender finish, but 42¼ to 42½ins. is quite sufficient for goods which require to be finished on the mangle.

Fig. 23 shows various methods of railing, and, although not by any means including all styles, may be taken as typical examples of many of the chief ways. A, although not the lightest railing, is the lightest in the illustration. When the width of cloth will not permit of much drawing, it is often used for a first run through or cylindering preparatory to a double chest finish. B is termed the "top single rail." C is the "three-quarter round rail." D is called the "single cross." E, which imparts about the same tension as C, is called the "single cross rail," but under the last or front bar. F is termed the "round rail," and is rather heavy. G is the "double cross" or "canvas rail" and is a very heavy form of railing. H is about the heaviest rail given to cloths—indeed, it is only heavy and good cloths that will stand this severe type of tension. In very wide calenders this type of railing is almost sufficient to break the rails.

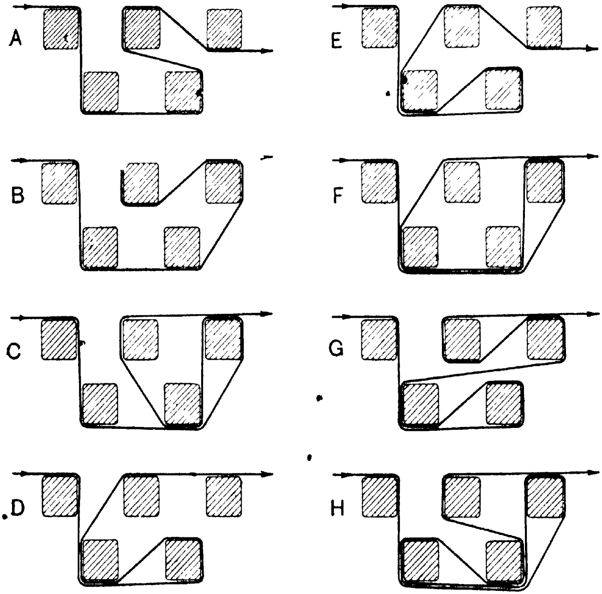


Fig. 23.

The various types of calender and of chest finish are more particularly indicated in Figs. 24 to 28. For the very lightest finish the cloth would be entered as shown in Fig. 24, and the weights caused to act in a negative direction. Cloth intended for this finish should be only slightly damped, since it is very lightly in touch with the drying cylinder, and two bowls only are resting on the cloth. Slightly heavier types of finish may be obtained under this system by removing the proper number of weights from the end of the belt Q (Fig. 18). The difference obtained by this means is, however, very slight, but a different finish will result, with the

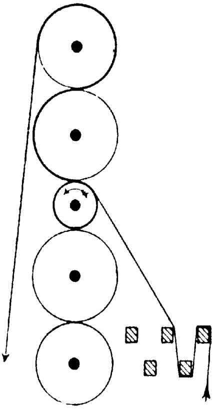


Fig. 24.

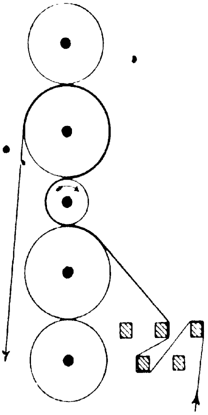


Fig. 25.

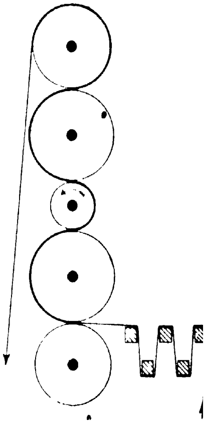


Fig. 26

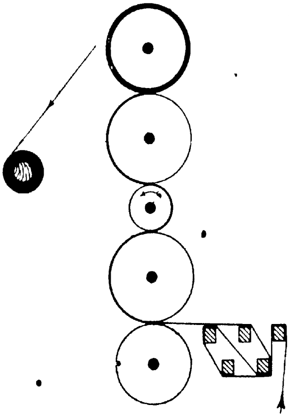


Fig. 27.

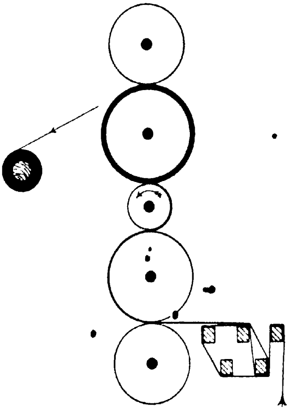


Fig. 28.

same method of entering the cloth, if the weights are made to act in the positive direction.

The method of entering the cloth as shown in Fig. 25, is often adopted for the finishing of sackings where it is desired to have a bright appearance on the face or warp side of the cloth. This finish is naturally obtained by allowing the face of the cloth to come into close contact with the steam cylinder. This method of entering the cloth may also be used to give a slightly heavier finish than that in Fig. 24, since another bowl, or three in all, rests upon the cloth. It will be seen that, when viewed from the end of the calender as illustrated, the steam cylinder rotates clockwise in Fig. 25, but counter-clockwise in Figs. 24, 26, 27, and 28. When the calender is driven in the reverse direction as illustrated in Fig. 25, that is, with the crossed belt, it usually runs slower than it does when driven by the open belt in the normal direction.

The heaviest calender finish is obtained when all the weights are used, and when the cloth passes between the bowls, as shown in Fig. 26. It is, of course, understood that different pressures will result when different numbers of weights are added, and consequently the degree of finish will vary a little, according to the number of weights which are used. In Figs. 24 to 26 the cloth leaves the bowls and then simply falls behind the calender in more or less irregular folds; the piece is then wrapped up in a sheet by an attendant, who takes it to the measuring machine. Besides seeing that the proper character of finish is being obtained by the addition of the necessary number of weights, the attendant should regularly test the cloth to make sure that it is being drawn in or finished to the proper width.

Sackings, baggings, and tarpaulins are usually treated to some type of calender finish, but the majority of hessians are either chested or mangled. If the cloth is to be mangled, it is considered good practice first to flatten the cloth by either calendering or chesting before "filling up" the cloth in the mangle,

Figs. 27 and 28 illustrate the two methods of entering the cloth for chesting. The former is the ordinary method, in which the end of the cloth passes between each pair of bowls and is finally carried round the top one; the whole piece is thus wound on to this bowl. The end of the cloth, which first enters the machine, is carried completely round the top bowl, and is then safely entered between the two top bowls by means of the chesting knife 15, which is shown at the back of the machine in Figs. 18 and 19. The cloth is then subjected to a heavy pressure for a few minutes. This pressure, which is applied to the outside of the cloth, is communicated from layer to layer through the medium of the cloth itself. It is this indirect pressure which is chiefly responsible for the somewhat irregular surface that is characteristic of all types of chest finish.

Heavy chesting, or chesting on the top paper bowl, is shown in Fig. 28, and it is simply a development of the ordinary method of chesting. It produces the same type of finish—an irregular corrugated-like surface, but, since it is usually done under very heavy pressure, it is very severe on the bowls. An excellent and stiff finish, however, is the result—a finish which is sometimes employed to imitate mangling. The superior finish thus obtained is due partly to the weight of the extra bowl, and partly to the fact that the cloth is continuously in touch with the steam cylinder. On this account the cloth should be well damped before finishing.

Figs. 24 to 28 also show a few more methods of railing, the chief object of which is to hold the cloth at a tension sufficiently great to prevent slackness or creases of the cloth from collecting on the bowls. Although such tensioning is absolutely necessary, it must not be overdone to the extent of reducing the cloth below the required finished width.

We have already referred to glazing, and have shown that the effect is obtained by means of heat and friction. This type of finish is, however, chiefly reserved for hessians and tarpaulins which have been previously loaded with starch and other weighting and adhesive materials. The introduction of these substances, in combination with the finish, stiffens the goods, which are then used for padding for several varieties of wearing apparel. Large quantities are dyed black and other colours, in addition to being starched, in order that they may be more in harmony with the goods they are destined to stiffen. After having been starched and dyed, the cloth is passed over a series of steam-heated cylinders to dry, and is then further damped before being finally finished on the glazing calender. In some cases the goods are simply dried off without any attempt at glazing.

Fig. 22 is a view of the actual process of calendering, in which it will be seen that wide pieces are being treated. Several other details of the machinery are illustrated in this reproduction, notably the method of driving the loose pulley, and from it the compound gearing for raising the rack rods. In the foreground of the same figure, and at the back of the machine, appear two pulleys. These are near the floor, and they give, with the continuation of the shaft, a partial view of one of the many motions adopted for the rolling of wide pieces direct from the calender. It is principally, and almost invariably, used for winding long pieces of wide hessians which are intended for the backing of linoleums and other similar floor coverings. Long lengths are most suitable for the linoleum process, and special machinery is made by a few Dundee firms by means of which nearly 4000 yards of cloth can be woven in one length, and simultaneously wound into a roll of approximately 6ft. in diameter. Lengths of 600 and 1200yds. are often made, but the usual lengths are from 300 to 450yds. In the calender a long arbor, square in section, passes through a square hole in a wooden cylinder. The winding is performed on this wooden cylinder as a centre, and is carried on continuously during the finishing process. When the whole of the piece has been wound on, the arbor is withdrawn, and the roll sent, as it stands, to the linoleum works; here the piece is gradually unwound, and when the operation is finished the empty cylinder is returned and the process repeated. In some cases the pieces for linoleum backs are measured before being finished and wound on the wooden cylinder; while in others a measuring apparatus is fixed to the winding part so that the exact length of the finished piece is known. In all cases the winding mechanism is driven by friction—thus providing means of dealing with the constant delivery of the cloth, although the diameter of the roll is constantly increasing.

## CHAPTER V

### MANGLING

MANGLING.—The essential difference between the operation of calendering and that of mangling lies in the fact that in the former finishing process every inch of cloth is subjected, in regular succession, to a comparatively heavy but somewhat momentary pressure during its rapid passage between the bowls of the machine, whereas in mangling, the whole piece of cloth of about 100yds. in length, is first beamed hard around an iron roller termed a "pin," then placed between the stones of the stone mangle or between the bowls of the hydraulic mangle, and for some time is there subjected to a continuous, and in most cases tremendous, pressure. During its stay of from 10 to 18 minutes between the stones or bowls of the machine, the direction of the rotation of the "pin" is repeatedly changed. This alteration of the direction of rotation under the heavy pressure employed, coupled with the fact that the pressure is imparted practically to the whole piece through the medium of the layers of the cloth itself, and not by the stones or bowls, directly accounts for the characteristic finish of mangled cloths. In many cases, and especially for the more expensive fabrics, the piece is protected by a cloth cover used only for this purpose. These cloth covers keep the pieces clean, and prevent the ends from being damaged. They are seldom used, however, for the less expensive jute fabrics. Mangled cloths, due principally to the above mentioned method of imparting the finish, have a full, soft, and mellow handle, which cannot be attained by other existing means.

All goods for mangling are first damped, and then either calendered or chested before being beamed for the mangle. The object of calendering is to flatten the thread before placing the piece in the mangle; the pressure of the mangle would probably damage the fabric if it were entered into the machine with the yarns in their original or semi-round condition. While calendering increases the length and decreases the width of the cloth, a slight reversion towards its original dimensions is calculated to take place during the mangling. Like all finishing of this class, the ultimate result depends greatly upon the degree of dampness of the cloth previous to entering the machine. If the cloth is too dry when entered, the frictional heat generated has not the same capacity for fixing or setting the yarns, and the latter have therefore a tendency to resume their original form when released from the pressure applied. Such a treatment gives the cloth a somewhat raw and unfinished appearance. Jute goods are usually considered as finished when they have been mangled, although they require to lie for a time in the stripped condition in order to cool before being made up. With many linens, however, and especially when the stone mangle has been used, it is not unusual, after mangling, to run the pieces through a calender under ordinary or glazing gear, in order to put a "skin" or glaze upon the fabric before making up. For yarn-bleached linen fabrics the mangle may be considered as fulfilling the purpose of the beetling machine in the finishing of cloth-bleached goods.

There are two types of mangles in general use:—

1. The stone mangle.
2. The patent or hydraulic mangle.

Of these the stone mangle is the older, slower, and more cumbersome machine, yet for many of the lower quality linen fabrics the results obtained by it are by many considered superior to the finish of the patent mangle. It is very suitable for cotton warp and dry-spun flax damasks, for mixed yarn dowlas, and for plain crashes. Border crashes are, however, not so suitable, since the extra thickness of the crammed border is likely to cause cutting. This difficulty is present even where the patent mangle is used, although it is more easy with the latter to beam the cloth in a slightly zig-zag manner and so prevent the extra thickness occurring all at one place. The same remarks are applicable to all goods with thick selvages. It is not advisable to beam long pieces for the stone mangle; better results are obtained if the average length is from 40 to 50 yds., than when it is 80 to 100 yds. Since the pieces are usually mangled twice, care should be taken to turn them end for end, and selvage for selvage, so that the ends which were originally nearest the stones and the pin respectively will now both be near the centre of the roll of cloth. This arrangement secures an equality of finish which is superior to that obtained when the pieces are not reversed, or when longer lengths are treated.

MANGLE BEAMING MACHINE.--Figs. 29 and 30 show front and end elevations of a mangle beaming machine made by Messrs Thomson, Son and Co., Limited, Dundee. It consists, as shown, of two substantial frames A which support between them several tension rails B, between and partly round which the cloth C is caused to take a zig-zag course in its passage from the roller D to the mangling pin E. The latter is driven at a constant surface speed (about 65yds. per minute) by frictional contact with the beaming roller F, on the arbor of which the fast or driving pulley G is keyed. The end of the cloth is wrapped carefully around the pin E so as to avoid creases, and during the beaming a constant pressure is maintained on the whole by means of a pressing roller H. This pressure is regulated by weights J, which act through the belt pulley K, pinions L, rack levers M (fulcrumed at N), and links O. The pressing roller H may be raised clear of the cloth, or lowered at will, through the medium of pinion P and hand lever Q, while pawl R, acting on the teeth of wheel S, retains the latter and the compounded belt pulley K in any desired position. When the beaming is finished, the pressing roller H is raised clear of the cloth, the arbor guides and supports T raised, and the pin containing the cloth removed from the machine. When beaming two narrow pieces on to one of the mangling pins, a minimum distance of about 3 to 4in. should, if possible, be maintained between them, while the same amount should be left clear between the outside selvages of the cloth and the sides of the stone. Pieces may, of course, be beamed from the loose or folded condition as well as from a roller—the method indicated in the figure. The belt U is transferred from fast pulley G to loose pulley V by means of the usual belt fork W, operated by handle X, fulcrumed at Y. The direction of motion is clearly indicated by the position of the belt and fork and also by the arrow Z.

The stone mangle shown in elevation and plan in Figs. 31 and 32

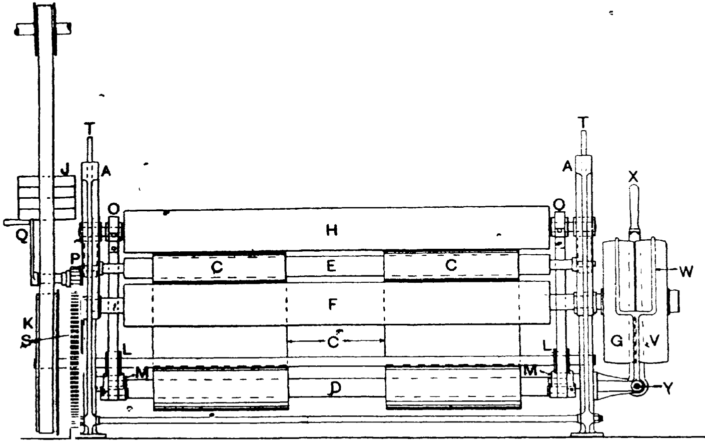

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Fig. 29.

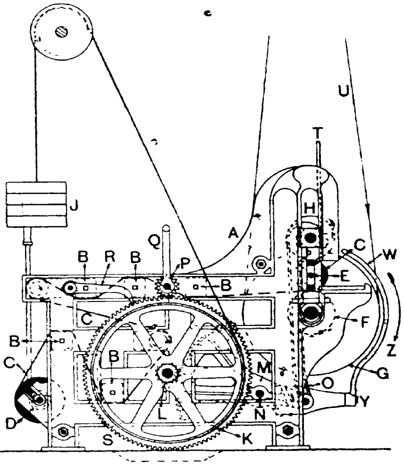
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Fig. 30.

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The stone mangle shown in elevation and plan in Figs. 31 and 32 stone alone, with box and inside ballast, weighs from 50 to 55 tons, and sometimes over. The foundations are invariably below the floor level line X Y. The stones A and B must be flawless, and

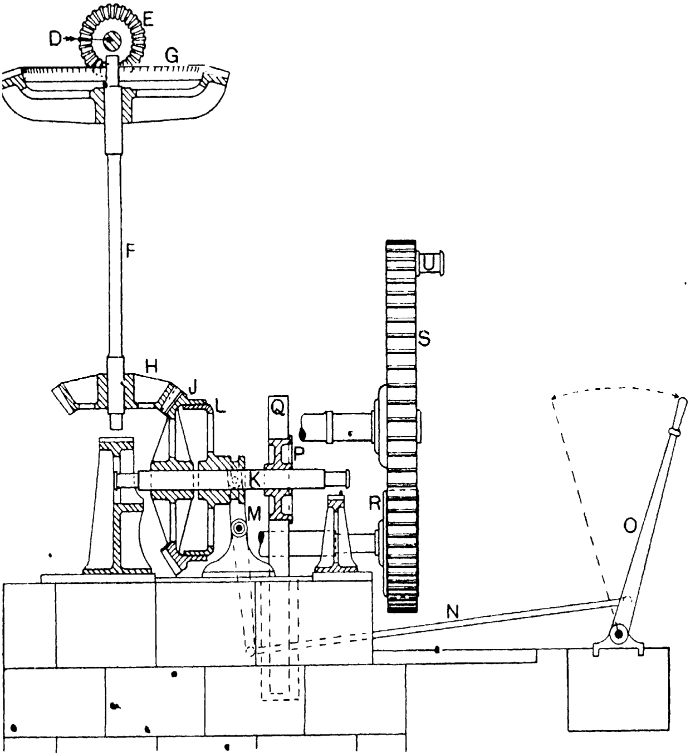


Fig. 33.

each must be in one solid piece, measuring, for an 86in. mangle, 12ft. long by 18in. thick. The top stone and box weigh about 15 tons, while ballast may be added in the box to the extent of 40 tons.

The gearing, of which an enlarged sectional view is given in

Fig. 33, consists of a line shaft D, from which a bevel pinion E constantly rotates the vertical shaft F through the bevel wheel G. At the lower end of F a further bevel wheel H drives the crown bevel friction wheel J, which may revolve loosely on the shaft K. On the same shaft the inner friction wheel L (of the couple J and L) is capable of sufficient lateral movement to place it out of, or in, frictional contact with J. A sunk key and keyway connect L and K, and the above-mentioned lateral movement to L may be imparted by the clutch fork lever M, connecting rod N, and hand lever O. When J and L are in contact, shaft K revolves, and so drives the mangle box, through pinion P, intermediate wheel and pinion Q and R, crank wheel S, and connecting rod T. To ensure strength, and to reduce as far as possible the probability of teeth breakages, the wheels are, where it is thought necessary, provided with shrouded teeth.

The total stroke of the crankpin U is 5ft. 11in.; or just under half the length of the mangle stone. It makes about four revolutions per minute, so that the average linear speed of the stone will be:

$$5\tfrac{11}{12}\text{ft.} \times 4 \times 2 = \text{about } 47\text{ft. per minute.}$$

The actual speed of the stone will, of course, vary throughout a complete revolution of the crankpin, being the greatest when the pin is at the top and bottom centres of its stroke. When the crankpin is at the front and back, or the dead centres of its stroke, the box is for a moment motionless at the extreme right or left positions. It is also evident that at this time more than half of the box and stone must be projecting over one or the other beam C, and therefore tilting downwards towards V or W. At both these points cushions and rollers are provided to receive the end of the stone until it begins to return on its journey and resume its horizontal position. When the slight pause is made at the extreme positions, slight adjustments are given to one or other of the beams C; the machine is also stopped when the box Z is in the tilted position, in order that the pin, with the finished cloth, may be withdrawn and replaced by a fresh pin. New pins of cloth must be placed at right angles to the run of the mangle, and those under the stone must be kept at right angles, otherwise it is possible to twist the mangle box off the under stone.

STRIPPING MACHINE.—The subsequent and necessary operation of stripping the mangle pin of its roll of cloth is performed by the machine shown in end and front elevations in Figs. 34 and 35. The arbor of the mangle pin A is supported in suitable brackets cast on the framework, and when the covering cloth has been removed, the loose end of the piece is entered between the stripping roller B and the pressing roller C. The former roller is driven directly by the driving belt and pulley D, while the deadweight of roller C, in conjunction with roller B, provides sufficient nip to pull the cloth from the beam A. The cloth then slides down a guide board E, which keeps it clear of the machine, and then passes over a plaiting or faking board F, which throws the cloth into a series of rough folds preparatory to a second beaming for the mangle, or to the subsequent finishing process by the calender. The faking board receives its to-and-fro motion from a short connecting rod G actuated by a small-throw crank on the shaft H, this shaft being driven by a short belt J from the stripping roller. The extreme positions of the faking board are shown in dotted lines.

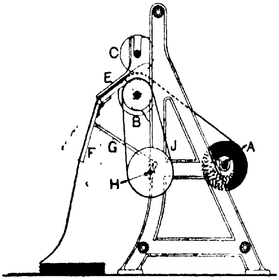


Fig. 34.

HYDRAULIC MANGLE.—There is a general similarity in the chief parts of all patent mangles, although the machines differ slightly in the mode of driving, as well as in some minor details. In each machine the finishing mechanism consists of two ponderous bowls—an upper and a lower—between which the mangle pin with the beamed cloth is inserted. The under bowl is supported in bearings cast on the framework of the machine, while pressure is applied by various means to the top bowl, and through the medium of this bowl to the cloth in process of being finished. It is almost needless to say that the bearings which support the bottom bowl are very heavy and massive, since the pressure applied to the upper bowl may, in extreme cases, reach about 18cwt. per inch of width, or approximately 118 tons on a mangle 132in. in width.

The drive is invariably taken by gearing to the bottom bowl which drives, by frictional contact, the pin containing the cloth. This, in turn, and by similar means, imparts motion to the top or mangling bowl, unless, as in some special cases, both top and bottom bowls are geared together.

Each machine is provided with self-acting reversing gear, by means of which the direction of rotation of the bowls and pin is regularly and automatically reversed during the process of finishing. This combined action of a frictional drive and repeated reversing of the direction of rotation of the cloth while under heavy pressure constitutes the chief secret of the mangle finish. Pressure is applied, as the title of the machine indicates, by means of water, but in some mangles the required pressure is obtained by means of oil, and in others through the medium of levers and weights. In each machine provision is necessarily made for raising the top bowl to permit of the removal of the finished cloth, and of the insertion of a fresh pinful. All patent hydraulic mangles are provided with self-contained cloth beaming and stripping motions, while in the modern machines the stripping roller or beam is arranged also as a measuring roller; this, in conjunction with the faking board, enables the cloth to be measured and deposited in loose folds as it is stripped from the mangle pin. In some of the older types of mangle the stripping roller is identical with that on the modern calender, so that the roller requires to be stripped again by a measuring machine to determine the cloth length, and to fake the

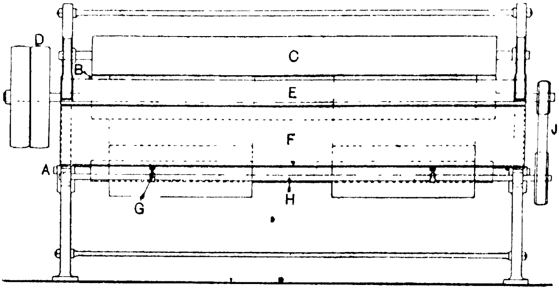


Fig. 35

cloth into loose folds in order that it may be cooled before being made up.

Different methods are adopted for changing the mangle pins or beams from the beaming to the finishing, and then to the stripping, positions. In an older style of machine only two pins are used: these slide horizontally, between the main frames, out of and into the finishing position, so that beaming and stripping are performed at each side of the machine alternately. In the more general arrangement, however, revolving plates are provided which carry three mangle pins, set 120° apart, as indicated in Fig. 36, where A indicates the position of a pin during the finishing process, and B and C indicate respectively the beaming and stripping positions of the other two pins. At the end of each run the plates and pins are mechanically rotated one-third of a revolution to bring the finished beam into the stripping position, and to carry the freshly beamed piece up between the finishing bowls. At the same time the stripped or empty beam is carried round to the beaming position to be refilled with another piece of cloth. With this arrangement, beaming and stripping are always performed respectively at the front and at the back of the machine.

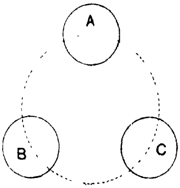


Fig. 36.

We have already pointed out that the top bowl may be driven by frictional contact with the cloth, or by gearing from the bottom bowl. The machine which we have selected for illustrating this section is provided with this gearing, which, however, may run loosely if desired. This gearing is arranged to keep the surface velocities of the bowls the same, to reduce the torsional strain in the bowls themselves, and to reduce frictional slip between the mangling bowls and the cloth in process of finishing. A reduction of slip is desirable in the case of many tender fabrics, such as union crashes and damasks, since it minimises the likelihood of damage being done to the cloth. For strong jute goods, however, the purely frictional drive is essential to the proper finishing of the cloth; better and quicker results are obtained by it, and with less pressure than with the geared drive. In a number of machines, therefore, this extra gearing is entirely dispensed with, while in others it is permitted to run loosely when the machine is being used for jute and other heavy fabrics.

Hydraulic pressure is usually applied by means of an accumulator of suitable design, while driving may be provided from the main drive, by a special engine, or by a motor of 75 to 100h.p. Should a public supply of electrical current be available, the latter method permits of the intermittent running of the mangle without annoying variations of speed in other machines, and it may also be in motion in busy times—as is sometimes essential—when the main engine has stopped for the day. For jute goods an average time of about twelve minutes is allowed, and, with this time per run, about forty runs per day of ten hours may be taken as good work.

Figs. 37 to 40 illustrate respectively the plan, the front elevation, and both end elevations of a hydraulic mangle of the most recent design, by Messrs Urquhart, Lindsay and Co., Limited, Dundee. Reference to all four illustrations is necessary for an understanding of the general arrangement of the machine, with its details of driving and gearing. Similar letters in all four figures indicate the same parts of the mangle: A is the heavy framework, B and C the top and bottom mangling bowls, and D the mangling pin—the latter part is shown only in Fig. 38 but the others appear in all four figures. We shall now trace the drive of bowl C, which is shown chiefly in Figs. 37 to 39 keyed on shaft $E^1$. A rope drive is almost invariably employed for mangles, and the rope pulley E of 60in. diameter is arranged to take from three to five ropes as required, and to make 130revs. per minute. Keyed on the same shaft as pulley E, and therefore revolving with it, is a helical toothed pinion F, which gears with and drives friction wheel G. The latter, which runs loosely upon its central shaft, is in gear with and drives, in the opposite direction, a similar friction wheel H, also loose upon its shaft. Near the framework A, and keyed upon the same shafts as G and H, are two pinions J and K, both of which are in gear with the large wheel L. This large wheel L is keyed on the central shaft of the bottom mangling bowl C. Situated about midway between, and on the same shafts as wheels G and H and pinions J and K, are two expanding friction clutches $G^1$ and $H^1$. Each clutch is compounded with its respective shaft by means of a sliding key and key-way, so that it may be put in contact, automatically or at will, with its corresponding friction

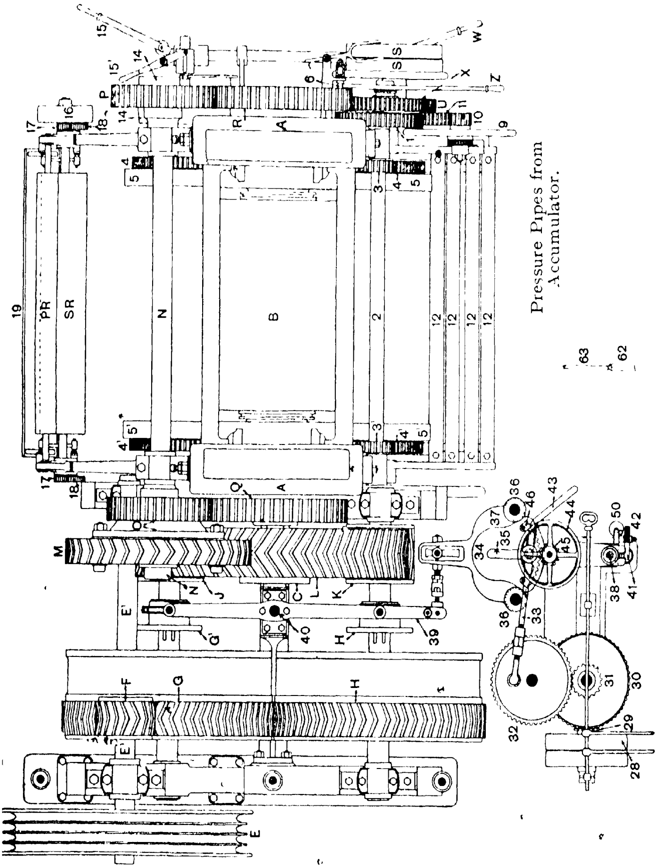


Fig. 37.

wheel G or H. If G¹ be placed in contact with friction wheel G, then clutch G¹, with its corresponding shaft and pinion J, will rotate wheel L in one direction; similarly, if clutch H¹ be placed in contact with friction wheel H, and the other be withdrawn, then wheel L and bowl C will be rotated in the other direction. When one clutch and pinion are driving wheel L, the other clutch,

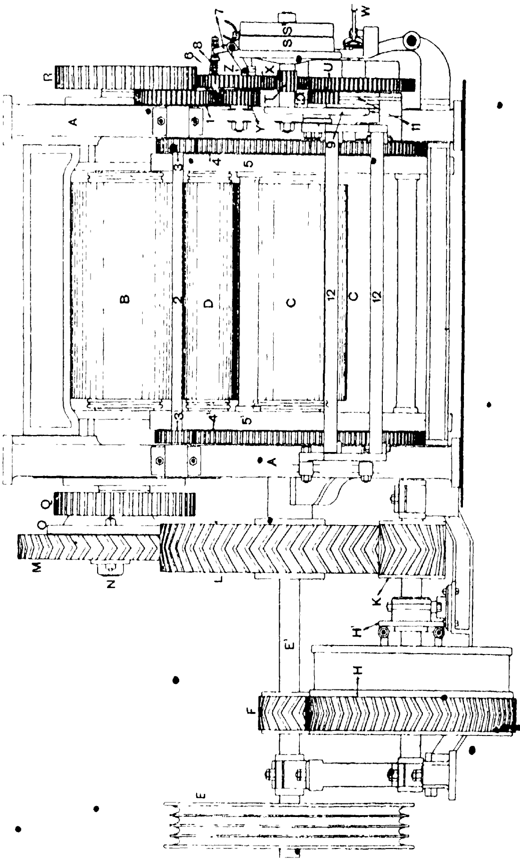


Fig. 38.

pinion, and shaft are revolving loosely in the same direction, being so driven by wheel L. When both clutches are brought to the central position—that shown in Fig. 37—the mangle is stopped.

The further gearing employed to drive the top mangling bowl

B consists of the helical toothed wheel M, arranged loosely on its central shaft N, wheels O and P keyed at opposite ends of the same shaft N, and gearing with wheels Q and R, which are keyed at opposite ends of bowl B. When it is desired to drive this bowl positively, wheels M and O are bolted together as shown in Figs. 37 and 38, but at other times the bolts are withdrawn, and, while all gearing runs, wheel M works loosely on shaft N. In many cases, as already indicated, shaft N, with all wheels M, O, P, Q, and R, are entirely dispensed with.

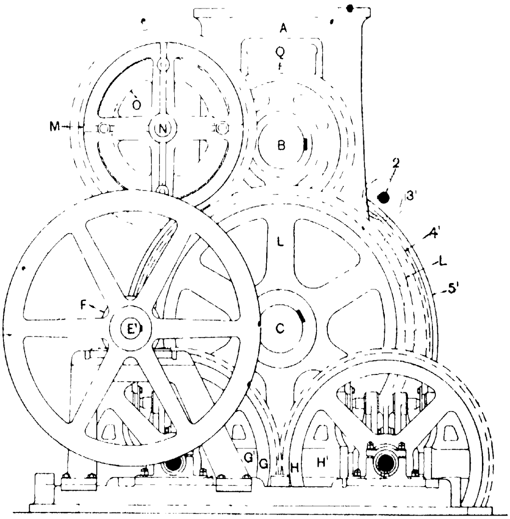


Fig 39.

Fast and loose pulleys S and S¹ are provided, and the former communicates motion to pinion T, which is geared to wheel U for the beaming motion, and to wheel X for rotating the plates which carry the three cloth pins. As each of these two motions may be required to be in action while the other is stationary, wheel X is fitted loosely upon its central stud, but it may be frictionally compounded with pinion Y, on the same stud, by the action of the clutch handle Z. The handle Z is connected to a small screw or worm near the end of the shaft, and a small downward movement of the handle forces wheel X sideways, so that a circular tapered bead cast upon its side engages frictionally with a corresponding tapered disc formed on the side of pinion Y; in this way motion is imparted to pinion Y. When X and Y are thus compounded, pinion Y drives wheel 1, and therefore shaft 2, while pinions 3 and $3^1$ communicate the motion to the large wheels 4 and $4^1$, which

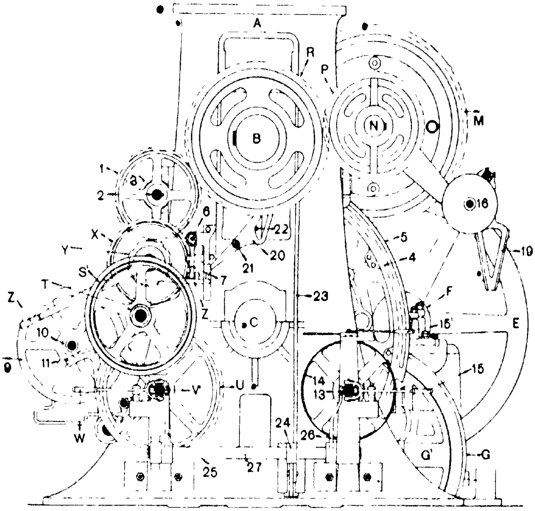


Fig. 40

are bolted to the revolving carrier plates 5 and $5^1$. When a change of beam is required, the top mangling bowl is raised clear of the cloth, wheel X and pinion Y are compounded as indicated, and plates 5 and $5^1$ rotated for one-third of a revolution. Revolving plates 5 and $5^1$ are retained in their proper position, while mangling is being performed, by the blocks of the top bowl; these blocks enter gaps in the plates, and the rotary movement of the latter is checked by a stop-pin 6 which passes through the framework and enters a hole in the plate. This stop-pin is withdrawn by the action of the handle Z and the bell-crank lever 7 at the same time as the wheel X and pinion Y are frictionally compounded. Immediately the plates 5 and $5^1$ have moved their proper distance the spiral spring 8 forces the stop-pin into one of the holes in the revolving plate, and at the same time breaks the frictional connection between the wheels X and Y, thus preventing over-running of the revolving plates and cloth pins. A safety device is fitted which prevents the rotation of the plates until the top mangling bowl is lifted and the pin in the mangling position set free to be moved round. The clutch handle Z is continued behind its connection with bell-crank lever 7, as shown in Fig 40, until its extremity is immediately underneath the lower arm of cam lever 20 fulcrumed at 21. With this lever in the position shown, wheel X cannot be compounded with pinion Y to rotate the carrier plates, but as bowl B ascends, the stud 22 connected with it acts upon the upper arm of lever 20 so as to place it in a more vertical position and set free the end of the lever Z, when the necessary action may take place.

The cloth beaming mechanism consists of the same fast and loose pulleys S and $S^1$ and pinion T: the latter drives wheel U on the pintle shaft V (Fig. 40), the squared end of which may be forced, by means of the clutch handle W, into the end of the mangle beam when the latter is in its proper position. A pressing beam is provided to assist in beaming the cloth hard on the mangle pin. This beam is not shown in the above figures, but it is brought into action by means of the hand-wheel 9, pinion 10, and toothed quadrant 11. Tension rails 12 (Fig. 37) are also provided to prevent the cloth being beamed in a creased condition, and to assist the attendant in guiding the cloth properly on the pin. A drive is also arranged to rotate the mangle pin when stripping This is seldom necessary for strong jute goods, since in such cases the pull of the stripping roller and cloth is sufficient to rotate the beam; but with light linen or union goods it is preferable to drive the beam positively, at least to begin with. The pintle shaft 13 (Fig. 40) for stripping is rotated by means of the belt pulley 14, and may be entered into the end of the mangle pin by clutch handle 15, while the belt fork for fast and loose pulleys 14 is operated by means of handle $15^1$. The fast pulley is wide enough to take two belts, and one of these belts, a crossed one, remains on the pulley and drives pulley 16 (Figs. 37 and 40) on the end of the stripping roller S R while pinions 17 (Fig. 37) on this roller gear with and drive crank pinions 18 ; this arrangement results in the rocking to and fro of the faking board 19. P R is a pressing roller of sufficient weight to ensure a proper grip of the cloth for stripping purposes.

A further safety connection is made from bowl B to both pintle shafts (Fig. 40) by the rod 23, levers 24, 25, and 26, and rocking shaft 27. This ensures that both pintle shafts V and 13 will be automatically withdrawn from the pins in the beaming and stripping positions respectively when the bowl B is raised preparatory to rotating the plates. Although this safety catch is sometimes neglected it is far wiser and safer to see that it is in use.

The self-acting reversing gear (*see* Fig. 37 for general arrangement) is actuated by means of an independent drive to belt pulley 28, then through bevel pinion 29, bevel wheel 30, and spur pinion 31 to crank wheel 32. From a crankpin on the latter wheel a connecting arm 33—adjustable in length with a view to regulating the positions of the clutches $G^1$ and $H^1$—is carried to a pin which projects from the upper face of cam 34, the latter being fulcrumed upon an independent centre 35. As wheel 32 revolves, cam 34 oscillates about its present central position and thus acts alternately on the anti-friction rollers 36, bolted at each side of the table lever 37. This lever, supported underneath on anti-friction rollers, is fulcrumed at 38, and is connected at its further end by means of a short arm to the clutch lever 39. The lever 39 is fulcrumed at 40, and it is clear that the lateral movement of this lever in one direction will place one clutch in gear and withdraw the other, while a lateral movement in the other direction will have the opposite effect. The short arm of lever 37 actuates a pawl 41 which gradually rotates a toothed bell-wheel 42 arranged to ring a bell 50 and thus warn the attendant at the end of a run ; in many cases this useful adjunct is neglected, and the length of each run is timed by the attendant. The connecting arm 33 is so fixed to cam 34 by the spring handle 43 that it may be readily detached. The hand wheel 44, pinion 45, and segment rack 46, on cam 34, provide means whereby the clutches may be placed in their central positions to stop the mangle, or by which either clutch may be kept in gear at the pleasure of the attendant when it is found necessary to rotate the mangle for a little time in one direction.

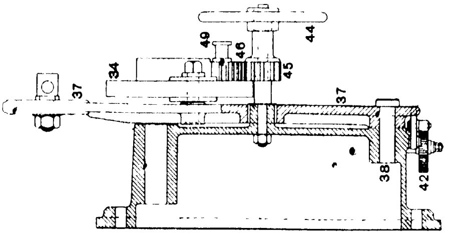


Fig. 42.

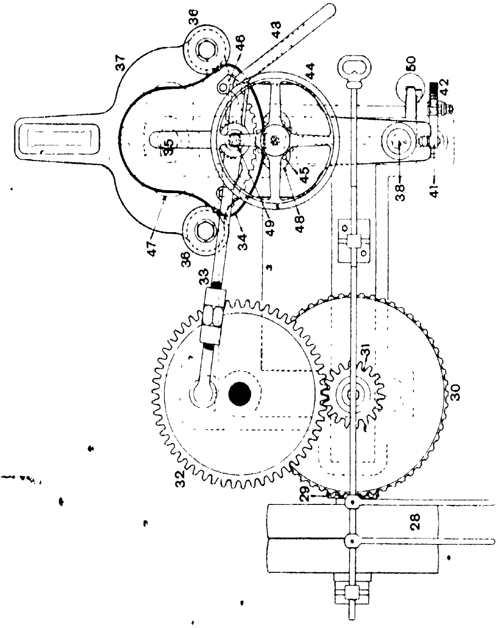


Fig. 41.

Figs. 41 to 44, show in detail the self-acting reversing gear. The fulcrum of the cam 34, and that of the hand-wheel 44, pass through the table-lever 37, and the latter is therefore provided at these points with concentric slots 47 and 48, as shown, to permit of the necessary movement of the table on its fulcrum 38. In Fig. 42 the sectioned part of the elevation is taken along the line of the table 37, and each part shown is numbered in keeping with the foregoing description. The connecting rod 33 is not shown in this figure, but the stud for placing the slot in rod 33 in gear with the cam 34 is shown at 49. The same remarks as to lettering apply to the elevations in Figs. 43 and 44, the lines of which have been taken through the centres of the driving pulley 28 and the crank wheel 32 respectively. In the former view the short arm of table-lever 37 is shown with details of the lever and pawl for actuating bell-wheel 42 and bell 50. As the short arm of lever 37 moves to the right, it causes the pawl 41 to rotate the bell-wheel 42. Projecting pin 51 ultimately reaches the bent portion of wire 52, when the bell is gradually forced out until pin 51 slips past the end of wire 52, the sudden release resulting in the ringing of the bell. When a large number of pieces require exactly the same time in mangling, the use of this motion relieves the attendant of part of his responsibility; but when a great variety of fabrics have to be treated on the same machine, the motion is, as already stated, often dispensed with.

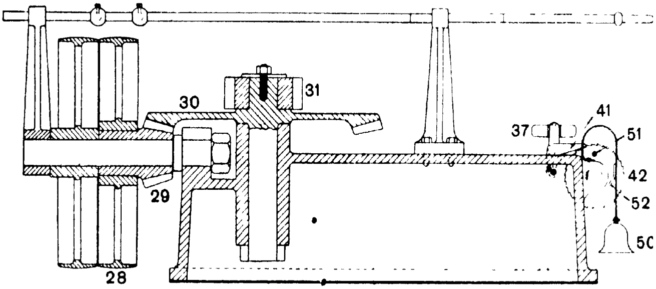


Fig. 43.

In Fig. 44 the method of connecting the arm 33 by means of the spring handle 43 to the stud 49 (Figs. 41 and 42) in cam 34 is more clearly indicated; a ring on the inner arm of lever 43 drops over the head of the stud 49, and thus sufficient pressure is exerted on the rod 33 to keep the stud and slot in contact. The figure also shows the anti-friction rollers 53 and 54 which support the table-lever 37 in its lateral movement.

An elevation and plan of the most recent form of accumulator are shown in Figs. 45 and 46, the letters and numbers in which are distinct from those of the mangle proper.

Referring chiefly to Fig. 45, the accumulator consists of two sets of weights, A to E, and 1 to 5, part or all of which may be supported by a 3¼in. ram acting upon a column of water in the cylinder F. By means of pipes, valves, and other connections, the cylinder F is connected with other cylinders and rams underneath the mangle, and so arranged that the potential energy created in the cylinder F may be caused either to lift or to depress the top mangling bowl at will. A double-acting force pump G is provided, mechanically driven through the pulley H, spur pinion J, wheel K, crank L, and double connecting arms M, by which the ram may be raised to reach and carry the weights referred to. Weights A and B, C and D, and E, which are supported when not in use by steps formed on the pillars N, give sufficient pressure by themselves to raise the top bowl of the widest mangle. They are also sufficient for light mangling pressures up to about 65 tons. For heavier pressures the ram must be pumped up to take one or more of the top weights 1 to 5. These are supported, as shown partly in section, by a series of double-ended pawls O, fulcrumed between the sides of the channel frame N. Pawls O are so fulcrumed that they constantly tend to assume the position shown, or, in other words, to support the weights. To bring any of the top weights into action, all the

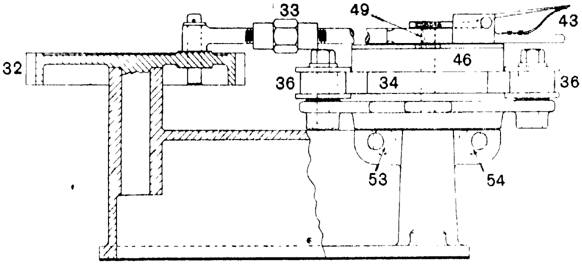


Fig. 44

other weights are first lifted by pump and ram, and, while the weights are in this position, the rack rods P are pushed up between the inner sides of N and the short arms of O to retain one or more of the latter in the vertical position until the weights are lowered to float with the ram and to act for mangling purposes. The rack rods P are controlled by means of pinions Q (*see* plan view, Fig. 46), wheels R and R$^1$, and pitch chain S, all brought into action by hand-wheel and lever U. To obtain, say, Nos. 1 and 2 of the upper set of weights, wheel R$^1$ must be rotated counter-clockwise until the number 2 on the disc S$^1$ is opposite the indicating finger V, and so on for any other number of top weights. The rotation of R$^1$ results in rod P being raised to a height which will retain the same number of pawls O vertical as are indicated by finger V. The vertical trigger rod T, which carries four ordinary triggers $T_1$ to $T_4$ and the safety catch $T_5$, is arranged to lift the short arm of a bell-crank lever W, when a pin projecting from the long vertical arm of lever W causes the belt fork bar X to slide in its bearings and thus enable the belt fork to carry the belt on to the loose pulley H$^1$. The pump is thus stopped automatically if the ram shows a tendency to rise too high during the working. It is also started automatically by the action of a weight or a spring on the same lever W when the weights descend. Triggers $T_1$ and $T_2$ are set in line with each other and work in conjunction with the horn on step weight C for light mangling pressures, while the triggers $T_3$ and $T_4$ are set in line and work in conjunction with step weight E. Thus, for light mangling, the trigger rod T will be raised to stop the pumps immediately the horn on C lifts the trigger $T_2$, while for heavy mangling, the same automatic stop comes into action when the horn on weight E raises the trigger $T_4$. Trigger $T_4$ should be so set that under ordinary mangling conditions the pump will be stopped before the top weight E, floating with the accumulator ram, picks up any of the weights that may still be suspended. The safety catch $T_5$ is provided to catch the horn on weight E should the latter miss trigger $T_4$; the pump is thus always stopped before the ram has risen too high. Trigger rod and triggers are controlled and worked by handle Y and quadrant gear to pinion Z on trigger rod T. The trigger rod T is square in section for a few inches in order that the pinion Z may rotate it and still allow the rod to slide up and down through the pinion. A rotary movement of the trigger rod of about 30° is sufficient to place either set of triggers into or out of position. When changing weights the trigger rod is rotated until both sets of triggers are out of position, and the circular safety catch $T_5$ only in use. This safety catch should be so set that the ram just eases all the weights clear of their respective catches During the operation of changing weights all connections to the mangle are shut. When the pawls O have been controlled by rack rods P, the ram and weights are allowed to fall a little by easing the safety valve through lever 6, and the trigger rod is again rotated to its working position. Two set of valves are provided and are operated by independent handles 7 and 8. One set admits and discharges water to and from the lifting cylinders while the other set fulfils the same purpose for the mangling cylinders. An indicator plate (*see* Fig. 45), is marked from left to right as follows:—

LIFT : LOCK UP : DISCHARGE : CHANGE WEIGHTS : MANGLE

and this shows the positions into which the handles 7 and 8 must be rotated for the various operations. When mangling is proceeding, the mangling handle 8 will be over at "Mangle," and the lifting handle 7 at "Discharge", when lifting the top bowl, handle 7 will be at "Lift," and handle 8 at "Discharge." When both handles are standing vertically, or opposite "Lock Up" and "Change Weights" respectively both delivery valves from the accumulator cylinder F and discharge valves from the mangle cylinders are closed; the accumulator ram and weights are therefore locked up. Should it be necessary while mangling to change the number of mangling weights, the handle 8 must be placed opposite "Change Weights," the pump started, and after all the weights are floating on the accumulator ram, the pawls O are controlled by the rack gear to suit requirements. When changing weights handle 7 may be at "Lock Up" or "Discharge," but not at "Lift." At times when lifting the top bowl, it may not be necessary to allow the accumulator ram to fall to the bottom, in which case the handle 7 may be put over to the "Lock Up" position. In all cases handles 7 and 8 should be moved slowly from one position to the other.

In an older type of accumulator there are, in addition to the

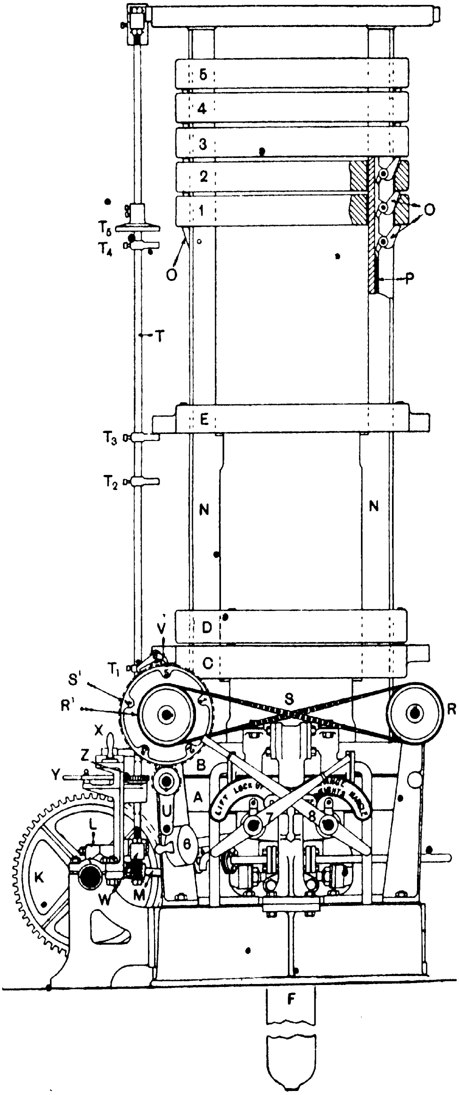


Fig. 45.

bottom sets of weights, about six pairs of weights at given distances apart. The triggers may be set so that the bottom set of weights may carry upwards one, two, or more pairs of the additional weights to obtain the desired pressure. For the heavier pressures the trigger rod is partially rotated as usual, to allow the plunger and weights to rise to the desired height, and to miss a certain number of triggers which represent the heights for lighter pressures. For the very lightest pressure the weights come into contact with the lowest or first trigger, and so on. In some of the modern accumulators a somewhat similar method is adopted, but single heavy weights are used instead of pairs of lighter weights.

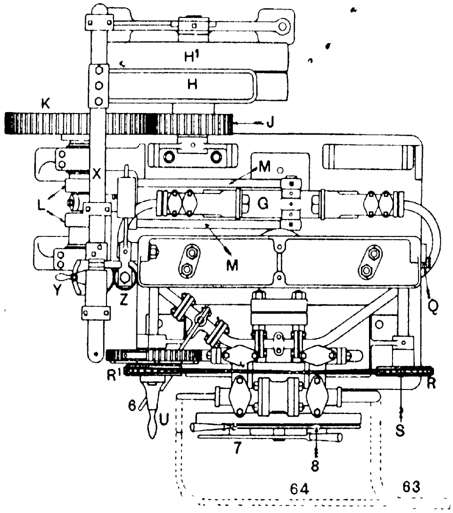


Fig. 46.

Figs. 47 and 48 show the mangle bowls B and C, mangle pins $D_1$, $D_2$, and $D_3$, together with the details of the beaming and stripping motions, and the arrangements of the cylinders. These two figures are partly in elevation, partly sectional, and partly diagrammatic. Thus in Fig. 47 part of the framework appears, but at other parts it is entirely omitted, while the revolving plates,

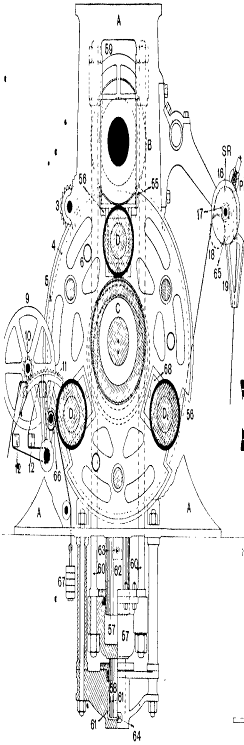

A
B
D
SR
PR
C
D1
D1
A
A

Fig. 47.

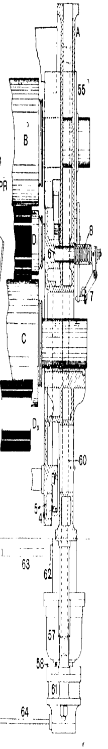

A
B
D
C
D1

Fig. 48.

pins, and lower bowl are viewed from the inside. The bearing block 55 of bowl B slides vertically in the framework A, its lower part when down fitting neatly into the corresponding gap 56 of the revolving plate 5, thus keeping the latter stationary during the process of mangling. This bearing block 55 is connected to cylinder 57 and ram 58, of 6in. diameter, by means of crosshead 59 and connecting rods 60, as shown, the ram 58 being free to work in fixed cylinder 61, which is rigidly bolted to frame A. Cylinder 57 receives the upper fixed, guiding and pressing ram 62 of 12in. diameter, but is capable of moving vertically with ram 58 to the extent of about 6in. Cylinders 57 and 61, and the corresponding cylinders under the other side of the machine, are connected by large and small bore pipes 63 and 64 (*see* also Figs. 37 and 46) to the corresponding valves of the accumulator, whence, at the will of the attendant, water under pressure may be admitted to either cylinder If cylinder 57 be open to discharge, and water forced into cylinder 61 through pipe 64, which will happen if handle 7 (Fig. 45) be at "Lift" and handle 8 at "Discharge," the ram 58, together with cylinder 57, rods 60, and block 55, will rise, being guided in this movement by fixed ram 62 and framework A. Thus the top bowl B may be raised until the lower end of the block 55 leaves the gap 56. Revolving plate 5, with beams or pins $D_1$, $D_2$, and $D_3$, is then, so far as the top bowl is concerned, free to be rotated. Before this can be done, however, it is necessary that the stop-pin 6 should be withdrawn. This is done by pressing down handle Z (Figs. 37, 38 and 40) which also starts the revolving plates. This movement of handle Z, as before mentioned, places friction wheels X and Y in motion, and through wheel 3 and wheel 4 (Figs. 38, 40, and 47) revolving plate 5 is rotated; but, at the same time as the forward end of Z is depressed, its rear end rises, thus lifting bell-crank lever 7, and, consequently, withdrawing lock-pin 6. This is, naturally, done in much shorter time than it takes to describe, since it is only necessary to push in the small handle which places the belt on to the driving pulley S, and to press down lever Z to ensure the withdrawal of lock-pin 6, and the simultaneous movement of plate 5. The latter, in one-third of a revolution, will clearly place pin $D_3$ immediately, under bowl B. Mangling bowl B must now be lowered, which may be done by opening cylinder 61 to discharge. The pressure in cylinder 61, due to the action of the accumulator weights, results, as shown, in lifting the bowl B; it is therefore clear that if any pressure other than the deadweight of bowl and bearings be brought to bear on the cloth which is wrapped round the pin, it must be by a downward movement of all the connected parts. In other words, the bearing block 55 must be pulled down by a force acting through the rods 60. By reversing the handles 7 and 8 (Figs. 45 and 46) to "Discharge" and "Mangle," water discharges from cylinder 61 (Figs. 47 and 48), while cylinder 57 is filled with water under heavy pressure through the pipe 63 and ram 62. The stream of water continues to flow until cylinder 57 is full, when the continued pressure acting inside the cylinder 57, and effectively on its base, easily exceeds the atmospheric pressure in cylinder 61, with the result that cylinder 57 and all connected parts move downwards, and thus exert the necessary pressure on the cloth through the medium of bowl B.

Since the diameters of the rams 58 and 62 are as 1 to 2, their sectional areas are as 1 to 4; consequently the simple change of direction of the flow of water from cylinder 61 to cylinder 57 converts an upward or lifting force of a given value into a downward or mangling pressure four times as great.

While mangling is proceeding, say, with $D_1$ between the bowls, it is customary to strip the newly mangled piece from pin $D_2$, and then to beam a fresh piece on the pin $D_3$, which is in the beaming position. The stripping motion is illustrated on the right of Fig. 47, where the cloth, shown in heavy line, passes from the pin and between the pressing and stripping rollers P R and S R (*see* also Fig. 37), and then between the sides of the faking board 19. The stripping roller is 1yd. in circumference, so that if required a measuring motion may be fixed on the end of the shaft of pulley 16. The faking board 19 receives its oscillating motion through the medium of wheels 17 and 18, and connecting rod 65.

The next operation is that of filling the pin $D_3$ on the left. The cloth is tensioned or railed, according to the strength of the fabric, by passing it over and under the four heavy iron rails 12. They are marked as if made of wood, but this is done merely to make them prominent. Wooden ones might be used in narrow mangles. In addition to passing over the rails, the cloth is often taken around the heavy shaft of the quadrant 11. Then it passes under the pressing roller 66, and finally around the mangle pin, which may or may not be first provided with a covering cloth. If the piece to be mangled contains unequal selvages, this arrangement of providing a cover rather narrower than the cloth to be mangled is often adopted, instead of zig-zagging the cloth when beaming it on the pin. Before beaming commences, the small retaining catch is removed from its ratchet immediately behind wheel 10, and the latter is then rotated by hand-wheel 9 until the quadrant 11 carries pressing roller 66 in close contact with the mangle pin. The pressing beam helps to make a firm pin in virtue of its own weight, but its power is considerably augmented by the action of a number of weights 67 acting as shown. As the beam fills, the pressing roller and quadrant are gradually forced back, and when all the cloth is firmly beamed on the pin, the hand-wheel 9 is again used to remove the pressing roller from the cloth. It will thus be seen that when the time arrives for removing the mangled cloth and for rotating the plate 5, there will be one empty pin $D_2$ and two filled pins $D_1$ and $D_3$. Although there is little difference between the weight of a full pin and that of an empty one, yet this difference, in conjunction with the rotating plate 5, is sufficient to cause a little trouble as to adjustment of the latter when no lock-pin is in use. The heavier pin has a tendency to carry the plate round a little too far, and this in spite of the slow and careful rotation. When, however, the lock-pin is in use, it immediately checks the plate 5 at the proper place for the insertion of block 55 into gap 56.

In the sectioned part of the shaft which carries bowl C are two small dots: the upper one is the centre around which C rotates, while the lower one is the centre of the revolving plate 5. The supports for the revolving plates are heavy circular beads cast on the inside of the framework: they are shown as heavily dotted circles in Fig. 47, but are more clearly illustrated in Fig. 48. The lower part of this latter figure is a section through the centre of roller C, while the upper part is through the lock-pin. Each beam or pin $D_1$, $D_2$, and $D_3$ is provided with sliding supports which fit into guides or slots 68 (Fig. 47), thus giving the amount of play necessary for different pins.

The ten weights of the accumulator (Fig. 45) vary slightly in weight, but average between 800 and 900lb. each. They act directly upon a ram of $3\frac{1}{4}$in. diameter, which imparts pressure to the pressing rams, each of 12 in. diameter. The pressure of the accumulator ÷ sectional area of ram in inches equals the pressure per square inch which is the same upon all; consequently, the accumulator pressure upon the mangling pin will be:

$$\frac{\text{Mass of accumulator weights} \times \text{sec. area of the two 12-in. rams}}{\text{Sectional area of the } 3\frac{1}{4}\text{-in. ram}};$$

while the total pressure is equal to the above, augmented by the weight of the top bowl and moving parts.

Thus, the increased pressure due to the addition of one of the top weights, each of which is approximately 820 lbs., will be:—

$$\frac{820\text{ lbs.} \times \frac{2(12)^2\pi}{4}}{\frac{(3\frac{1}{4})^2\pi}{4}} = \frac{820 \times 2 \times 12 \times 12 \times 4 \times 4}{13 \times 13}$$

$$= 22{,}358 \text{ lbs.}$$

$$= \text{approximately } 10 \text{ tons.}$$

The following table shows the mangling pressures which may be obtained by the different weights of this accumulator:—

| | | Tons. |
|---|---|---|
| I | Pressure due to weight of top bowl and moving parts (average) . | 10.25 |
| II. | ,, ,, above parts + bottom step weights A and B | 33 75 |
| III. | ,, ,, ,, and weights + middle ,, ,, C ,, D | 57.12 |
| IV | ,, ,, ,, ,, + top ,, weight E | 67.62 |
| V | ,, ,, ,, ,, + suspended weight 1 | 77.75 |
| VI. | ,, ,, ,, ,, + ,, ,, 2 . | 88 33 |
| VII. | ,, ,, ,, ,, + ,, ,, 3 | 98.32 |
| VIII. | ,, ,, ,, ,, + ,, ,, 4 | 108 25 |
| IX | ,, ,, ,, ,, + ,, ,, 5 . | 118.25 |

Figs. 49, 50 and 51 show the general arrangement of accumulator, piping, and part of mangle for a left-hand-driven machine. Fig. 49 is a front elevation of the accumulator at E, but a side elevation of the lower part of the mangle framework at A. Fig. 50 is a front elevation of the lower part of the framework of the mangle with cylinders and pipes underneath; while Fig. 51 shows a plan view of the connections of the pipes between the accumulator and both sides of the mangle. The various details of cylinders and piping will be readily followed from the foregoing text in connection with Figs. 47 and 48.

Previous to mangling, both large bowls should be covered with hessian or other strong jute or linen cloth in order to remove the danger of rust stains and similar damages. Special solutions are sometimes used for fixing on this cloth so that it may stand until it is practically worn down to the bowl.

The operation of mangling might be summarised as follows: Assuming that the top bowl is down, and that the cloth has been passed round the necessary tension rails, the pressing roller is brought up against the mangle pin in the beaming position, the beaming motion is started, and the mangle pin thereby filled with cloth. When this pin is filled, and the cloth between the bowls sufficiently mangled, the top mangling bowl is raised clear of the revolving plates by admitting pressure from the accumulator to the smaller or lower cylinders under the mangle gables or framework. The revolving plates are then set in motion by means of the handle provided for that purpose, and by the same movement the stop pin is withdrawn. The motion of the plate is automatically stopped, as already described, when the newly filled beam has rotated to the vertical position. The top bowl is now lowered by discharging water from the small cylinder to the pump cistern until the projections on the ends of the bowl blocks fit into the corresponding gaps of the revolving plate. The reversing gear is now put into motion, and after the cloth has had a turn or two with the top bowl and other deadweight parts only, hydraulic pressure

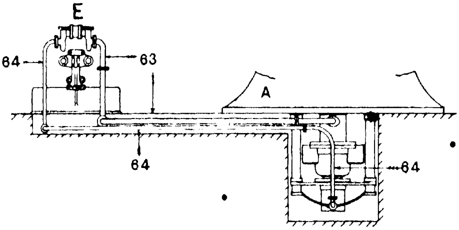
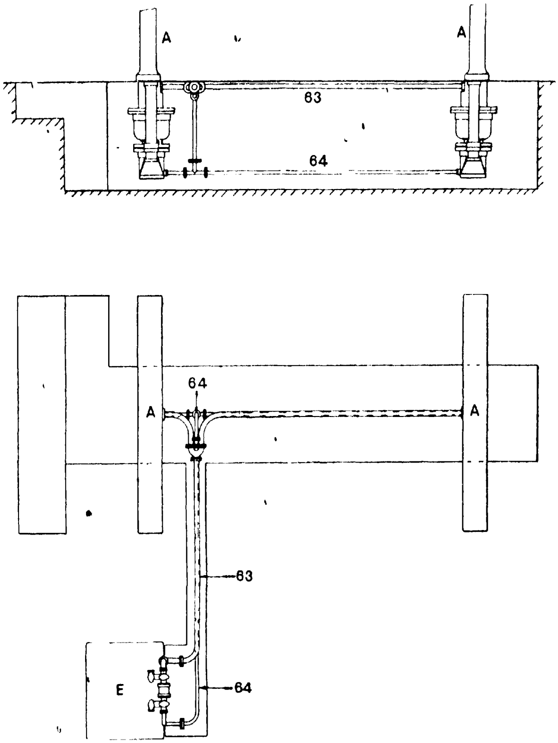


Fig. 49

may be applied gradually by using one or more accumulator weights, according to the finish required. While the mangling operation is proceeding, the mangled piece is stripped and then



Figs 50 and 51.

another piece is beamed on to the pin which is in the beaming position. The mangle continues to run until the piece is sufficiently mangled, when the reversing gear is stopped, the top bowl raised, and the revolving plates put in motion. The above-mentioned operations are repeated, but now the beam that has just been mangled may in turn be stripped while the operations of beaming and mangling are going on.

Figs. 52, 53 and 54 illustrate one of the latest mangles. They represent a 132in. machine which is specially driven by a motor of 100h.p. The current is conveyed from the dynamo to the motor by cables, which, in Fig. 53, are clearly seen emerging from the wall, and which pass to the screw switch-board, shown in Fig. 52. From here their course is easily followed to the motor, which, as will be seen, turns a driving drum containing seven rope grooves.

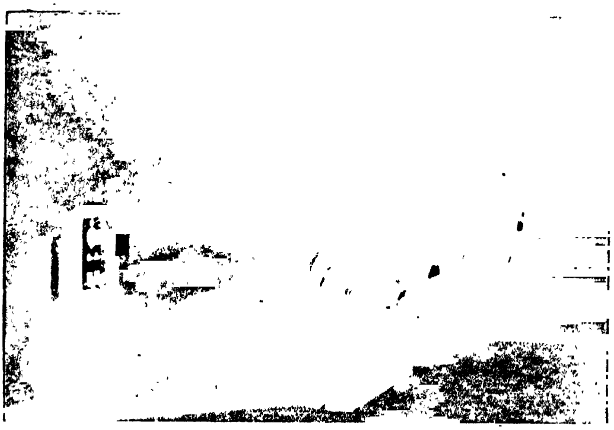


Fig 52

Three of these grooves are to be used for driving a calendar, while the remaining four drive the main rope pulley of the mangle.

Switchboard, motor, driving end of mangle, and accumulator are all clearly shown in Fig. 52, while Fig. 53 is a full view of the mangle and accumulator taken from the front of the machine, and this view shows the relative positions of the accumulator and the mangle. Fig. 54 shows the back of the mangle and the end opposite to the main drive. All the parts here will be easily followed from the description given in reference to the line drawings; indeed, with the single exception of the stripping motion, which in this case is fixed low down for greater con-

Fig. 53

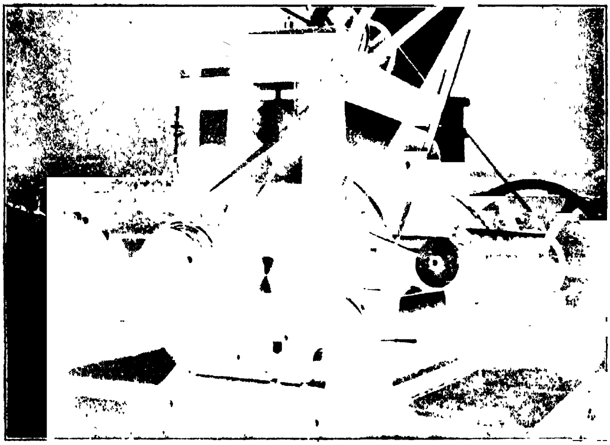


Fig. 54

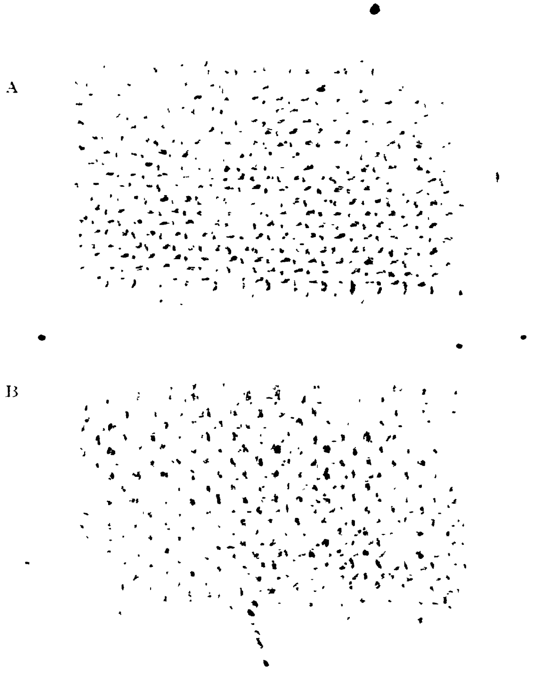


Fig. 55

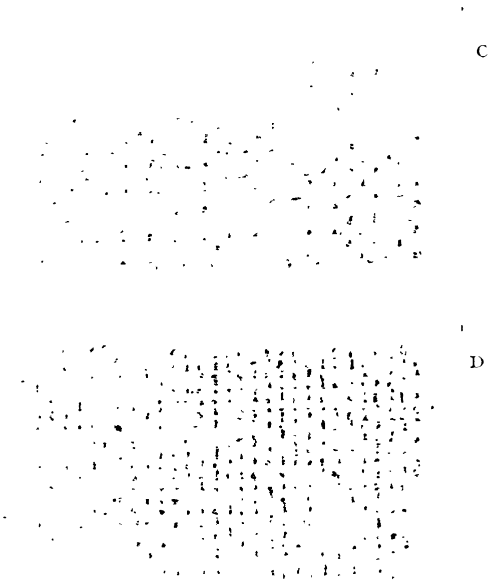
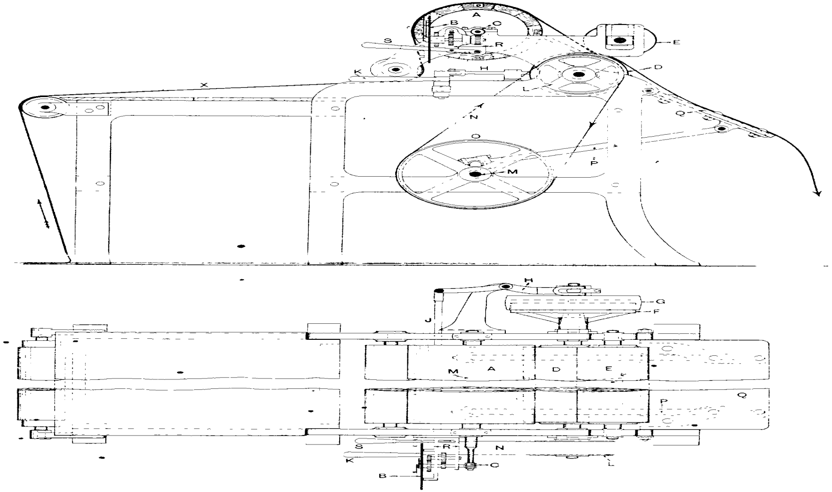


Fig. 56

venience, all parts occupy identical positions. We are indebted to Sir James K. Caird, Bart. of Ashton Works, Dundee, for permission to illustrate this up-to-date example of a modern finishing machine.

As a closing paragraph to this section of mangling we might recapitulate the chief differences which exist between the various types of finish, and in this connection we reproduce in Figs. 55 and 56 the same cloth in four distinct stages. Pattern A (Fig. 55) shows the cloth as it appears in the loom state, or at least after cropping. In the second stage, B, termed "calender finish," the single layer of cloth has been more or less heavily pressed as it passed rapidly between the various bowls of the calender, and therefore the yarns of the fabric are simply flattened out. If, while the fabric is being passed between the bowls, it is also wound upon one of the upper bowls and then subjected for a time to a continuous rolling pressure, the finish is termed "chesting," and a cloth of this type, in which the threads acquire a characteristically corded appearance, is illustrated at C (Fig. 56). Finally, the fabric shown at D illustrates the typical mangle finish which is similar to C, but filled up better.



Figs. 57 and 58.

# CHAPTER VI

## MEASURING, MARKING AND ROLLING

MEASURING.—Since practically all jute and linen piece-goods are sold by the imperial yard, their accurate and rapid measurement in the finished condition, prior to making-up, forms an important item in the sequence of finishing operations. In the earlier stages of the industry measuring by hand was a common practice, and this process is still resorted to, although perhaps infrequently, where limited quantities require to be treated. In order to minimise error, however, and especially if a considerable quantity of goods requires measuring, it is essential that a machine of some type or other should be employed. Measuring and lapping or folding may in some cases be carried on simultaneously, and so may measuring and crisping; but the general, and perhaps most desirable, practice is to employ a distinct machine for the purpose of determining the length of the piece.

There are several types of machines for recording the length of textile pieces, but most of those used in the jute and linen industries are somewhat similar to that made by Messrs Urquhart, Lindsay and Co., Limited, Dundee, which is illustrated in end elevation and plan in Figs. 57 and 58. This machine consists primarily of a measuring roller A, which is built up of sections as shown in Fig. 57, and then turned up truly from end to end until a uniform circumference of 36 ins. is obtained. A recording dial or clock B is provided, the necessary hands and gearing of which are driven by means of a single thread worm C on the end of the central shaft of the roller A. Situated behind the measuring roller, or to the right of it in the illustration, are two heavy cast-iron rollers D and E, the former of which may be operated by means of a fast and a loose pulley, or by friction pulleys as illustrated at F and G in Fig. 58. The outer friction pulley G is controlled by the lever H and rod J from the eccentric handle K situated near to the clock B. The upper roller E is supported by bearings which have a free movement in the vertical slots at each end of the machine; the arrangement being such that the roller E rests upon, and is frictionally driven by, the roller D when the latter is set in motion.

The cloth, shown by the heavy line X, is led from the stripping roller of the calender, or other machine, and passed over guide rollers as shown; it is then passed around the measuring roller by hand, and automatically guided between the rollers D and E. These rollers are then set in motion, and the nip between them serves to draw the cloth rapidly through the machine. The measuring roller is provided with perforated metal strips, or else with a few short spikes or hackles which project from its surface and engage with the cloth, so that the measuring roller is driven at the same surface speed as that which the cloth attains as it passes through the machine.

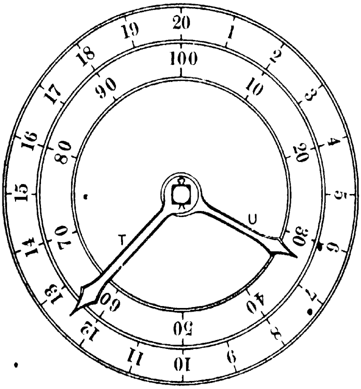


Fig. 59.

Pulley L is keyed to the arbor of the roller D, and drives the cranked shaft M through the short belt N and the pulley O. The cranks on M are connected by means of arms P with the faking board Q, which thus receives a rapid to-and-fro motion, and throws the cloth into loose laps or folds ready for making-up.

The single-thread worm on the end of the shaft of roller A communicates motion to the gearing of the clock B as shown. The clock and gearing are mounted in and supported by a movable bracket R, which is controlled by the lever S. A slight downward movement of S withdraws the gearing from the worm C, when it is necessary to place the hands of the clock to zero, which is essential at the beginning of each piece. An upward movement of the lever

S then places all in gear ready for the measuring operation. Brass insets are usually provided on the end of the measuring roller A to indicate the zero mark—which should be on the top and coinciding with the end of the piece when starting—and the divisions of ¼, ½, and ¾yd. When nearing the finish of the piece the machine should be slowed down by reducing the frictional contact between the pulleys F and G—thus permitting the end of the piece to be brought slowly and gradually to the top of the measuring roller. Complete yards may then be read off from the clock, and fractional parts of a yard from the insets on the end of the roller.

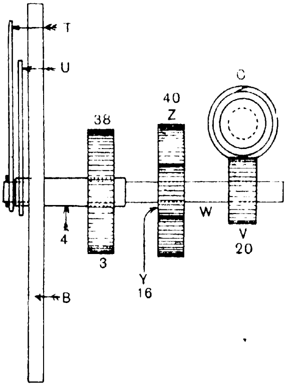


Fig. 60.

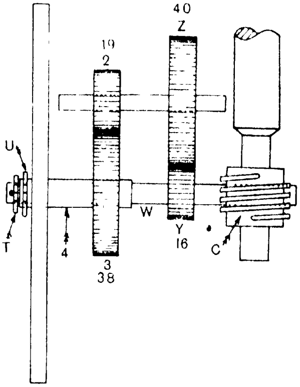


Fig. 61.

Figs. 59, 60, and 61 show, on a larger scale, a front elevation of the clock face B, and an end elevation and plan respectively of the necessary counter wheels. The single-thread worm C causes the worm V to move one tooth for every revolution of the measuring roller A. Since worm wheel V has 20 teeth, it follows that 20revs. of the roller A, and its equivalent 20yds. of cloth, will cause V, and the spindle W to which it is attached, to make one revolution. This spindle is carried through the clock face, and on its square end the units hand T is fixed; the hand T therefore moves round with V, and indicates on the outer or units circle of the clock the number of yards of cloth which has passed through the machine.

Fixed also on spindle W is a small pinion Y of 16 teeth, which gears with and rotates the pinion Z of 40 teeth. Compounded with the wheel Z is another pinion 2 of 19 teeth, which gears with and drives the wheel 3 of 38 teeth, fixed at one end of a short sleeve 4. The other end of the sleeve 4 passes through the clock face, and upon this end the tens hand U is frictionally fixed. The sleeve rotates round spindle W, consequently the tens hand moves with it, and thus records the length in multiples of ten on the inner circle of clock B. The length indicated on the clock in Fig. 52 is therefore 32½yds.

One revolution of T × V or 20 teeth = 20 revolutions of C
—that is, 20 yards of cloth.

One revolution of U × $\frac{38}{19} \times \frac{40}{16} \times \frac{20}{1}$ = 100 revolutions of C
—that is, 100 yards of cloth.

Some machines are fitted with an automatic motion for breaking the connection between the spiked measuring roller and the clock when the end of the piece reaches the former. A small spiked roller is rotated slightly by the flick of the end of the cloth, and this roller in turn operates a handle to lower the clock out of touch with the worm on the end of the measuring roller. The mechanism, after having performed this function, is brought back to its normal position by a spring.

When the only object in view is that of obtaining the length of the piece, the machine previously described is all that is necessary. It is often desirable, however, especially in the case of many types of linen fabrics, that the cloth should be not only measured, but also marked with the length measured every yard, that half-yards should be indicated, and that the piece should be ultimately rolled into compact form ready for retail sale. In such cases the three distinct operations of measuring, marking, and rolling may be carried on simultaneously; but if the cloth is intended to be lapped instead of rolled, it is measured and marked and simultaneously faked into folds ready for the lapper.

Figs. 62, 63, 64, and 65 are respectively illustrative of the two end elevations, front elevation, and plan of a measuring, marking and rolling machine of this character made by Messrs Robertson and Orchar, Limited, Dundee. In this machine the ordinary method of driving by fast and loose pulleys is replaced by a belt which passes over the driving shaft near the ceiling and then around flanged pulley A (see Figs. 63, 64, and 65). The belt is slack when the machine is inoperative, but is made taut when ready for work by the downward movement of lever B (Fig. 62), and the retention

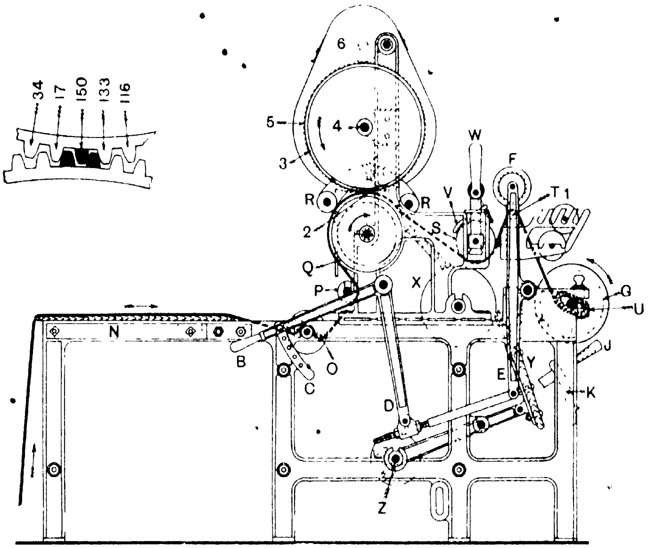


Fig. 62.

of the latter in its new position by means of a stop pin which enters guide C. This downward movement of lever B moves the pendant arm D of this lever, and the lower arm of the straight lever E, to the right, and consequently the belt pulley F at the opposite or upper end of E to the left. Pulley F is thus made to press against and to tighten the driving belt, which then imparts motion to pulley A. This is the usual arrangement for an overhead drive.

In a precisely similar manner pulley $A^1$ (Figs. 63, 64, and 65), drives the pulley G on the end of the rolling bars by belt H shown in double lines in Fig. 63. The belt is thrown out of action by pressing down handle J after withdrawing the stop pin from one of the recesses in guide K. This stop pin L at the end of the spring lever M fits neatly into any of the recesses, and thus keeps the handle J in the required position, while the latter may be readily released by means of hand pressure on the upper end of M. The arrows indicate the direction of rotation of the different rollers.

The cloth passes from the floor over the table N (Fig. 62), under tension bars O, under guide roller P, and over the measuring roller Q, being kept in close contact with the latter by the rollers R. The roller Q may be clothed with perforated strip metal to ensure that the surface speed of the roller will be the same as the speed of the cloth which is passing over it. The cloth then passes under the roller S, over rail T, and is finally attached to the roller bars U. These bars are driven by the pulley G in the direction shown, and they draw the cloth forward and roll it as indicated in the figure. The roller S, when in the position shown in Fig. 62, does not rotate, but acts as a tensioning roller or rail. It is kept stationary by

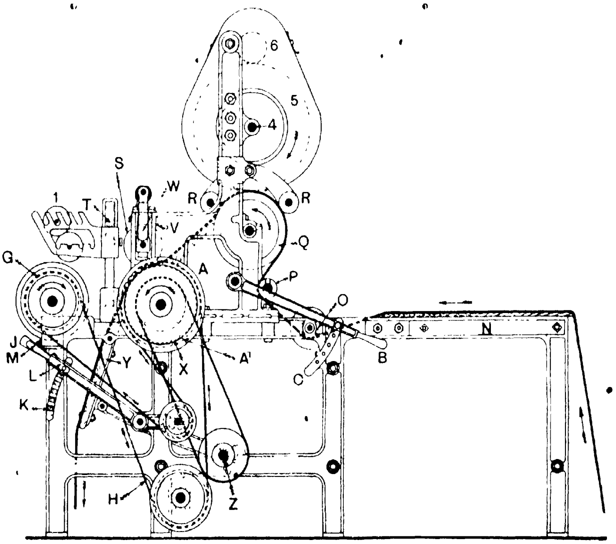


Fig. 63.

the pressure of the end of the lever V, which grips the roller when the handle W is up. The turning of this handle from its lowest position (Fig. 63) to that shown in Fig. 62, rotates a small eccentric, shown in black behind handle W, through half a revolution; it then raises the roller S and depresses the braking end of the lever V indicated. It is therefore evident that this arrangement gives a choice of the following two positions:—

1. With eccentric and handle W down, as in Fig. 63, and the cloth gripped between rollers S and X, both of which rotate.
2. With eccentric and handle W up, as in Fig. 62, and the cloth raised out of contact with the rotating roller X, but railed or tensioned by means of the now stationary roller S.

The handle is always in the top position when the piece is being rolled, as in Fig. 62; but if, as stated, the piece requires to be lapped, then the handle W is placed in the low position (Fig. 63), so that the rollers S and X, which are now in contact, draw the cloth forward over the faking board Y. The faking board receives its motion from a connecting arm and crank on shaft Z as shown, this shaft being driven by either a crossed or an open belt from a pulley on the same shaft as the pulley A; an open belt in heavy lines is indicated in the figure. When the rolling operation is completed, the roller bars U may be rotated into the position shown in Fig. 65, and the bars themselves made to collapse or to approach each other by a movement similar to that of the bars of a parallel ruler. This action removes the pressure between the edges of the bars and the cloth, and thus facilitates the removal of the latter. If extra-wide cloth requires to be treated on this machine, it is passed through in the ordinary way and between rollers I, before being attached to the bars. Such pieces are, however, usually made up by hand.

Having illustrated and described the method of drawing forward the cloth and delivering it according to requirements, it now remains to show how the cloth is measured and marked. The measuring roller Q is one yard in circumference, and its shaft carries a worm connecting with the necessary wheels to a clock in exactly the same manner as described in connection with the ordinary machine illustrated in Figs. 59, 60, and 61. This roller Q also carries wheel 2, which drives the wheel 3 on shaft 4. The shaft 4 also carries the printing wheel 5, the type or numbers of which receive the ink from pad 6. The number of teeth in the wheels 2 and 3 depends upon the maximum number of yards to be marked. The diameter of the pitch line of the wheel 2 should be the same as the diameter of the measuring roller Q, and when 100yds. is

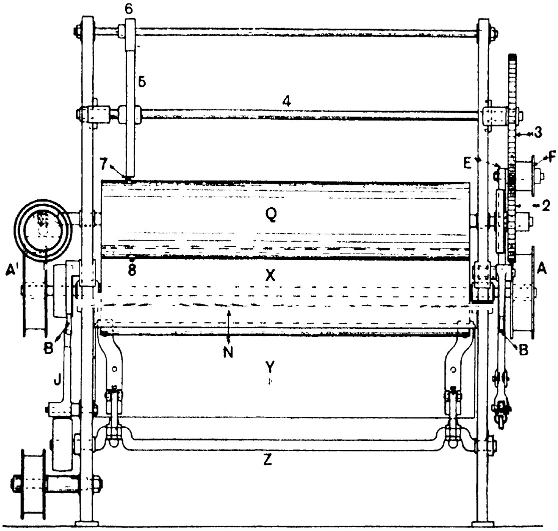


Fig 64

the maximum length required, wheel 2 contains 99 teeth and wheel 3 contains 100 teeth. If, therefore, the 100 numbers on the printing wheel or figure circle be in regular order from 1 upwards, and exactly opposite the 100 teeth in wheel 3, starting with No. 100 touching the printing block on roller Q, one revolution of the roller Q and wheel 2 will rotate wheel 3 through a movement equal to 99 teeth, or one tooth short of a complete revolution. Since the numbers on the figure wheel, as seen from the end elevation in Fig. 62, run counter clockwise, this movement would clearly place the next figure No. 1 immediately over the printing block on the roller Q with No. 100 behind on the left of the block. Each revolution of Q imparts $\frac{99}{100}$ of a revolution to the printing wheel 5, so that it takes 100 revolutions of Q, or 100 yds. of cloth, to complete the cycle on the printing wheel 5. The numbers on the printing wheel or circle receive the ink from the pad 6, so that each number is made to imprint its form on the cloth at the proper time. In addition to printing the numbers, it is usual to mark the cloth every half-yard by a small horizontal mark, or dash.

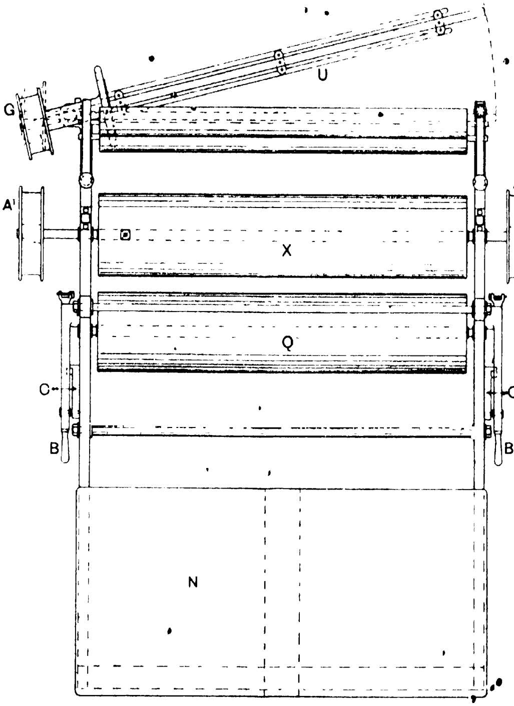


Fig. 65.

It is evident that contact between the numbers on the printing wheel and the cloth should occur only at such intervals as we have mentioned—*i.e.* every half yard—and to accomplish this the following arrangement is adopted. At two points, diametrically opposite to each other, on the circumference of the roller Q (Fig. 66), appear two blocks (7 and 8), and the cloth receives its impression as it passes between these blocks and the printing wheel. The blocks 7 and 8 consist of two pieces of wood enclosed in a brass box, the whole being let into the roller Q. Both blocks are adjustable, and when printing is in operation they project above the surface of the roller. They are adjusted so as to raise the cloth at these points into contact with the figures and the dashes of the printing wheel 5. Block 7, which is nearer the end of the roller than block 8, acts for the full yards, while block 8 is used for the half-yard marks between the figures. Both blocks may be sunk flush with the surface of the roller when measuring only is required. The relative positions of numbers, dashes, and blocks are shown in Fig. 66; but in the machine the numbers themselves are, naturally, reversed, so as to give the proper impression on the cloth. They would, however, be in numerical order, for measuring 100 yds. and not as illustrated.

Fig. 66 is an enlarged view of a part of Fig. 62, which illustrates a machine in which the numbers rise to 150, and in this case it will be seen that the numbers on the figure wheel do not appear in consecutive order. The number of teeth in wheels 2 and 3 must be prime to each other in order that all the numbers may appear by the time the cycle is completed. Numbers 99 and 150 are not prime, but one of the nearest numbers to 99 which is prime to 150 is 97. The two last-mentioned numbers are used when the machine has to mark up to 150 yds. With two such wheels :—

| | | | | | |
|---|---|---|---|---|---|
| 1 | revolution of small wheel, or | 97 teeth | = 1 | revolution of large wheel | - 53 teeth. |
| 2 | ,, ,, | 194 ,, | = 1 | ,, ,, | + 44 ,, |
| 3 | ,, ,, | 291 ,, | = 1 | ,, ,, | + 141 ,, |
| 4 | ,, ,, | 388 ,, | = 2 | ,, ,, | + 88 ,, |
| 5 | ,, ,, | 485 ,, | = 3 | ,, ,, | + 35 ,, |
| 6 | ,, ,, | 582 ,, | = 3 | ,, ,, | + 132 ,, |
| 7 | ,, ,, | 679 ,, | = 4 | ,, ,, | + 79 ,, |
| 8 | ,, ,, | 776 ,, | = 5 | ,, ,, | + 26 ,, |
| 9 | ,, ,, | 873 ,, | = 5 | ,, ,, | + 123 ,, |
| 10 | ,, ,, | 970 ,, | = 6 | ,, ,, | + 70 ,, |
| 11 | ,, ,, | 1067 ,, | = 7 | ,, ,, | + 17 ,, |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 12 | revolutions of | small wheel, or | 1164 teeth | = 7 | revolutions of | large wheel | + 114 teeth |
| 13 | ,, | ,, | 1261 ,, | = 8 | ,, | ,, | + 61 ,, |
| 14 | ,, | ,, | 1358 ,, | = 9 | ,, | ,, | + 8 ,, |
| 15 | ,, | ,, | 1455 ,, | = 9 | ,, | ,, | + 105 ,, |
| 16 | ,, | ,, | 1552 ,, | = 10 | ,, | ,, | + 52 ,, |
| 17 | ,, | ,, | 1649 ,, | = 10 | ,, | ,, | + 149 ,, |

Now, if we were to start with figure No. 1 on the block of roller Q, the next figure to appear on the block should naturally be No. 2; but since the two wheels contain respectively 150 and 97 teeth, there must be 150 − 97 = 53 numbers inserted in the figure wheel before the next numerically consecutive number appears *i.e.* there must be 52 numbers between 1 and 2, between 2 and 3, . . . and between 150 and 1. It is necessary, of course, to start with No. 150 on the block, so that No. 1 may appear after the first revolution of roller Q—that is, after one yard of cloth has passed through the machine. We also find from the above table that the interval between consecutive numbers on the figure wheel is 17, consequently the numbers on this wheel are arranged in the following order:—1, 18, 35, 52, 69, 86, 103, 120, 137, 4, 21, and so on at intervals of 17, finishing with 134.

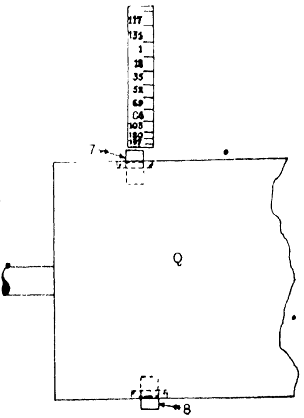


Fig. 66

Five consecutive teeth, with the proper numbers, are shown in the detached view in Fig. 62; number 150, the highest number, being in position when its corresponding number in the figure wheel is in touch with the cloth. Three teeth are marked in the two wheels as shown in the detached figure, so that they may always be set properly in gear in the position shown at the commencement of each piece. Wheel 2 on the measuring roller Q slides out of gear with the wheel 3, in order to facilitate the adjustment of the relative positions of the two wheels.

# CHAPTER VII

## CRISPING AND ROLLING

CRISPING OR DOUBLING.—Although the bulk of jute fabrics and a large proportion of linen fabrics are less than 45in. in width, there is a large variety of much wider goods made in both these sections of the textile industry. To facilitate the making up, packing and future handling of such cloth, it is found convenient and almost essential to reduce much of it to about half its original width, by doubling it selvage to selvage along the entire length of the piece. In the jute industry this operation is technically termed "crisping," and is usually carried out on a machine which is specially constructed for jute goods. In Lancashire this operation is termed "creasing," and in Yorkshire it is known as "rigging." The process of crisping, combined with the subsequent process of rolling—a process to which crisped pieces are usually submitted—has a tendency to twist or draw the yarn out of its normal or evenly woven condition. This deflection or distortion of the yarns from their true course is more marked in the weft than in the warp; but since both are more or less affected, it is usual to employ the two processes of crisping and rolling to those goods only which are intended for unimportant purposes. Thus, packing canvas and similar fabrics which are cut up for the general carrying trade may be so treated, but jute hessians, intended for linoleum backing and similar important purposes are invariably made up in their full width.

Since rolling usually follows crisping it is natural that several attempts have been made to combine the two processes in the same machine, and although the dual process presented great difficulties, the solution has been satisfactorily solved. Combined crisping and folding or lapping machines have been used for some time in certain branches of the textile industry, and so have combined crisping and rolling machines, but it is only a few years ago since a machine of the latter type was introduced into the jute and linen industries. And even yet crisping and rolling form two distinct processes in most calenders or finishing departments, and in these places it is seldom that crisping is adopted for cloths under 50 inches in width. Simple rolling machines must however be provided for those narrow goods which require to be rolled in their single width. The operatives, must, of course, know in what form the goods are required, and making-up instructions for jute fabrics apart altogether from the particular type of finish which is to be imparted to the cloth—usually state either :

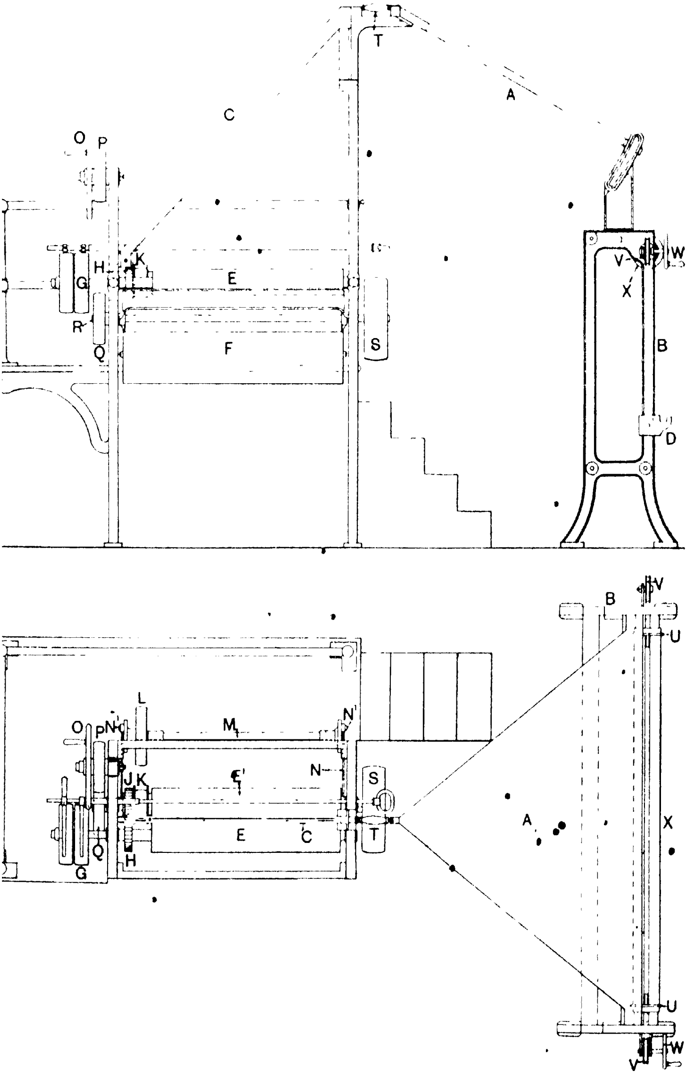
1. Roll full width.
2. Crisp and roll
3. Lap full width

Rolled goods are usually "stitched," and lapped goods "tied," to keep them intact during transit. In odd cases special forms of making-up may be required for particular reasons unknown to either the merchant or the finisher.

Crisping has at all times a marked tendency to affect the finish of the fabric: this defect may be slight in the case of soft and flexible goods, but it is more pronounced in fabrics which are firm and stiffly glazed and finished, and particularly so if the crisping is accomplished mechanically. Hence, bleached linen damasks and all the finer grades of linen fabrics, whether intended for distribution in piece or other form, were, up to a few years ago, invariably crisped by hand, when such an operation was necessary. For similar reasons, lapping, the chief form employed for the ultimate making-up of linen goods, was also usually performed by manual labour. Crisping and lapping by machine may be, and often is, practised for a rough making-up of these goods preparatory to forwarding them to the bleachfield; but when the cloth is in this stage, the operations are more easily carried out. Afterwards, hand labour is largely employed, but the mechanical methods are also being adopted. The making-up of all kinds of goods is now performed by both methods.

Figs. 67, 68, and 69 illustrate respectively a side elevation, a plan, and an end elevation of a standard crisping machine made by Messrs Urquhart, Lindsay and Co., Limited, Dundee. The actual doubling or crisping apparatus consists essentially of the triangular guide board A and the double diagonally set steel guides C. The cloth to be crisped is placed immediately behind the framework B. It is usually brought here in a loosely folded condition and deposited on the floor, but provision is made (see brackets D, Fig. 67) for crisping the cloth from the stripping roller of the calender, or from any other roller. In both cases, however, the cloth is passed full single width over the triangular guide board A, the narrow apex of which causes the cloth to double over on itself about a central longitudinal line. It is then in a favourable condition for being deflected at right angles between the diagonally set steel guides C. The doubled end of the piece is passed between these angular guides, and is then entered between the fluted drawing rollers E and E$^1$, each about six inches diameter. These drawing rollers, which are driven positively, grip the cloth in its doubled or crisped condition, and thus draw the piece rapidly through the steel guides above and deliver it to the double faking board F below, which deposits it, in loose folds, on the floor. Motive power is applied by the ordinary fast and loose pulleys G, which are placed as shown on the end of the drawing roller E, and roller E$^1$ is in turn driven positively from roller E by toothed gear wheels H and J. In close proximity to wheel J on the drawing roller E$^1$ is a flanged pulley K, and a short belt from this pulley passes round the pulley L on the crankshaft M; the latter being thus kept in motion in unison with the movement of the drawing rollers and the cloth. Pulley L and the faking board F (Figs 68 and 69,) are connected by means of crankpins N$^1$ and connecting arms N. Drawing rollers E and E$^1$ are supported in sliding blocks which may be suitably adjusted so that the rollers may be set for different thicknesses of cloth.

Compounded with the hand-wheel O, near which the attendant stands while crisping is taking place, is a pulley P from which a belt is taken to pulley Q on the shaft R. At the opposite end of this shaft a further pulley S (Fig. 67) is situated, and from this pulley S a broad canvas belt is carried over the small pulley T supported near the apex of the triangular guide board A. This canvas belt is thus situated immediately under the centre of the cloth in process of being doubled; indeed, the belt and cloth are in close contact.



Figs. 67 and 68.

A slight movement of the hand-wheel O is therefore sufficient to move the cloth slightly to one side or the other, and thus ensure that the selvages will be either virtually side by side, or, as is some times preferred, not quite coincident.

Shaft R also acts as the fulcrum on which the faking board F is hung. Near the base of the triangular board A adjustable cloth guides U are provided to centralise the position of the cloth while it is passing on to the guide board, and so facilitate successful doubling. Both guides U are so connected to an endless band which passes over grooved pulleys V—one guide to its upper reach, and the other to its lower reach—that a movement of the band in one direction by hand-wheel W will either close or open the guides equally with regard to the centre of the guide board A. Guides U are supported by and move freely along a suitably grooved roller X. Sometimes a rope is stretched over the roller, and in

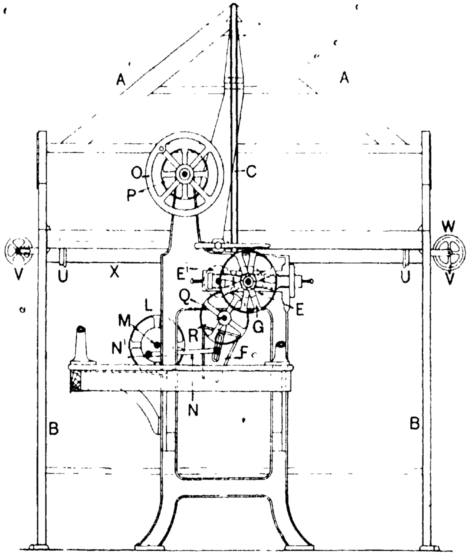


Fig. 69

the two longitudinal slots, and suitable hoops are arranged to slide on the rope for the same purpose.

ROLLING.—This form of making up cloth either in the crisped or full-width state is usually accomplished by means of a very simple machine termed a calenderoy, or briefly "roy." As shown in end and front elevations in Figs. 70 and 71, the machine consists of two

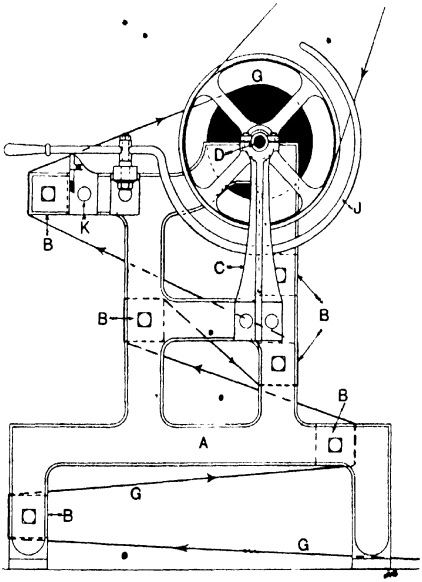


Fig 70.

substantial frames A between which are supported a series of strong wooden tension rails B. One of the frames A carries a heavy cast-iron bracket C which provides a bearing for the outer end of a short shaft D. This shaft is further supported by a bearing in the same frame A, and is, in this case, provided with an ordinary fast-and-loose pulley drive. In some machines a friction drive is fitted, and stepped cone pulleys are provided so that a variety of speeds may be obtained. The majority of machines, however, have the simpler type of drive as illustrated in the figure.

The inner end of the shaft D is swelled so that it may be recessed at E to take the squared head of the tapered bar or "spit" F upon which the cloth G is wound. The smaller end of F is supported in an open bearing at H, so that at the end of each rolling operation both the spit and the piece may be quickly and easily lifted out, and the former withdrawn from the centre of the piece. The latter operation is accomplished by dumping the thin end of the spit down upon a hard wooden block resting on the floor until the piece slips off; the selvages are then forced into line with each other by beating the edge of the rolled piece with a flat weapon.

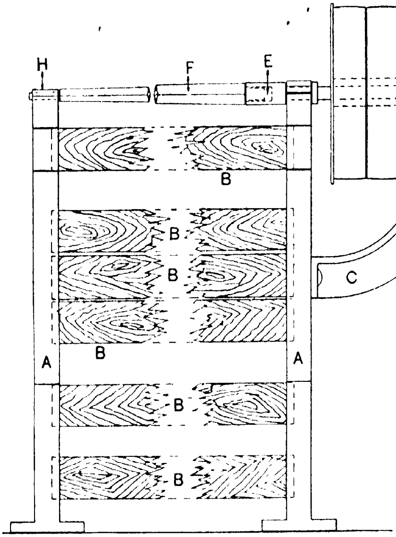


Fig. 71.

The sectional form of the spit may be square as shown in Fig. 71, or either of the shapes illustrated in Fig. 72. Spits with sections similar to that shown in the upper view are most generally used, but either the square or the hexagonal form is better suited for heavy carpetings or mattings, and for other wide goods which require to be rolled in their full width.

The pieces to be rolled are brought to the " roy " in the loosely folded condition in which they are delivered by the measuring or by the crisping machine. Each piece is placed behind the rolling machine as required by the attendant, who then proceeds to " rail " the cloth round the tension bars B in such a manner that a sufficient strain will be imparted to it during the process of rolling, and a firm piece thus ensured. The loose end of the piece is passed round the spit F, and one or two turns of the latter made by hand to make sure that it has gripped the cloth properly; this being ensured, the driving belt is moved on to the fast pulley by means of the belt fork J. The bracket K retains the belt-fork lever in either the on or the off position as desired.

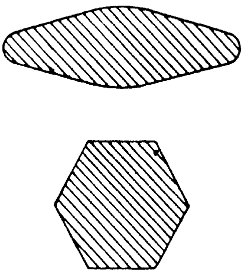


Fig. 72.

The attendant sits upon a stool while the piece is being rolled, and guides the selvage of the cloth by means of his right hand resting on the top rail B, and his right foot on the bottom or first rail B round which the cloth passes. His left hand, and sometimes his left foot, may also aid in guiding the cloth while it is being rolled. It is usual to slacken the piece slightly upon the spit before lifting both out of the machine. This is done by preventing the spit from turning in the forward direction, and then forcing the piece partially round it in that direction. In some cases this is found to be unnecessary. Pieces thus rolled are sometimes sheeted and stitched before being removed from the machine, but the general practice is to remove the piece first and to hand it over to another operative, who sheets it on a table—that is, he folds in the badly finished end of the piece, and stitches it up ready for the stamper.

The method of railing the piece as indicated in Fig. 70 may, of course, be varied at will by the attendant, but two, or at most three, different methods will be found to give all the variation in tension that may be required.

A very successful crisping and rolling machine is that known as the "Acme Creasing Machine" and made by Mr A. Bicket, Manchester. Figs. 73 to 75 illustrate the type which is made for jute fabrics, while a very similar, but rather lighter, machine is made for linen goods. Whenever doubled cloth is run over tension rails, there is a tendency for creases or scrimps to be formed, but in this machine the cloth passes direct from drawing rollers into the rolled condition free from creases, and the combined processes of crisping and rolling are performed at the rate of 110 to 130 yards per minute.

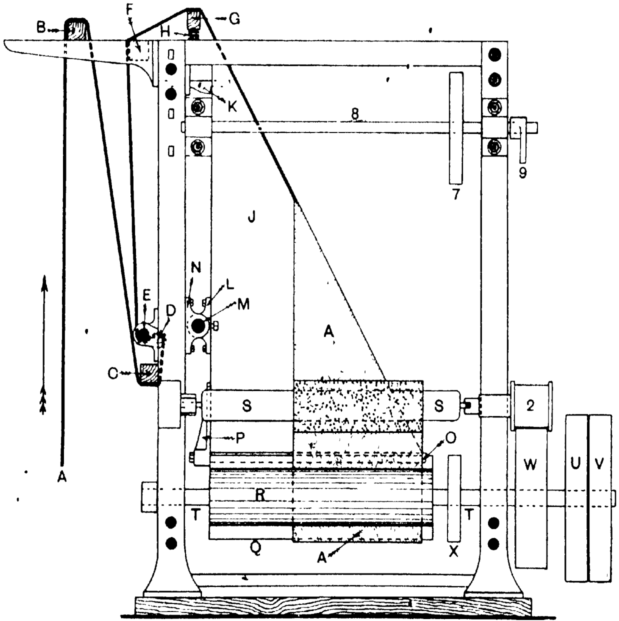


Fig. 73.

The cloth A, in its full width, passes over and under guide rails and bars B, C, D, E, F and G, the latter being capable of yielding slightly in virtue of the springs H which encircle two studs fixed to the underside of the rail. After the cloth leaves the rail G it passes down a guide J, covered with tin; the shape of this guide will be seen in Figs. 73 and 74. The framework of the guide is held quite firmly by brackets K and L, the latter being held by the thick rod M in a bracket N which is bolted to the framework. The cloth now passes between two parallel bars O, which are held rigidly in bracket P fixed to the back of the guide support, and it then passes partially round roller Q, over the top of roller R, and then direct to the spit S. The guide J, near the parallel rods O, is comparatively thin, but naturally wide enough for the desired double width of the cloth.

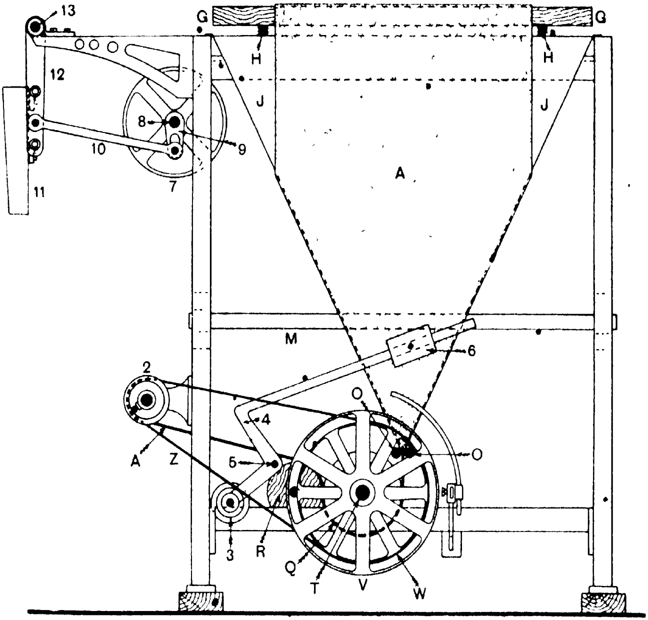


Fig 74.

The main shaft T of the machine carries the fast and loose pulleys U and V, broad pulley W, pulley X and roller Q. The latter, in conjunction with roller R, in adjustable bracket Y (Fig. 75), draws the cloth forward, while a belt Z, from pulley W, passes round grooved pulley 2, and the latter winds the spit S. The delivery of cloth from the rollers Q and R is constant, and the rate of winding the cloth on the spit S must also be constant. It is clear, however, that the turns per unit of time of the spit S must decrease gradually as it is being filled. The belt Z keeps the cloth A taut between the roller R and the spit S, but slips on pulley 2 more and more during the process of winding the cloth on to the spit. A tension pulley 3, operated by lever 4, fulcrumed at 5, and an adjustable weight 6 may be used if necessary, but this is not often required.

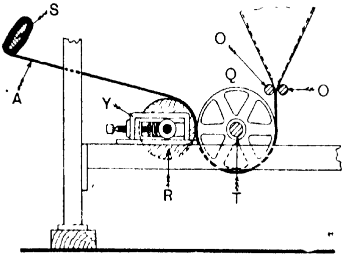


Fig 75.

When the end of the cloth reaches the position indicated in Fig. 73, or rather a little before this, the end is sewn to another piece, usually by a sewing machine, and the crisper restarted until the end reaches the spit. The machine is then stopped, the two pieces separated, and then both spit and cloth are ready to be lifted from the supports. Before lifting them out, however, a strong hook, which hangs from a stud on the framework, is swung round to hold the spit firmly while the cloth is turned slightly, as mentioned in connection with the calenderoy, to facilitate the removal of the spit S. The end of the spit is dropped on to a block of wood, and the spit may then be easily withdrawn from the centre of the roll of cloth.

A plaiting-down or faking apparatus of the usual type is provided if desired, so that the cloth may be crisped only. This apparatus is driven by a belt, not shown, which passes from pulley X (Fig. 73), to pulley 7 on shaft 8 A crank 9 and connecting rod 10 (Fig. 74), then serve to drive the faking board 11 ; the latter is secured to the bracket 12 and oscillates about the fulcrum 13.

# CHAPTER VIII

## LAPPING, FOLDING, OR PLAITING

LAPPING.—In the making up of tablecloths, napkins, towels, dusters, etc., either hemmed or fringed, or in the individual or the collective condition, the operation is often performed by hand, and is invariably some form of lapping or folding This process is, as we have already mentioned, most important and necessary for many types of fabrics; but even in the making up of jute and linen goods in the piece form, lapping or folding is perhaps more important as a method than rolling, and it is almost invariably adopted for the better-class goods which are produced in both these sections of the textile industry.

There is no doubt that a rolled piece is exceedingly convenient for the general retail trade; but unless it be rolled on a board or other similar flat centre piece, the first few yards to be rolled are generally crinkled, particularly if the cloth is folded, and are therefore inferior to the rest of the piece. Rolling as a process is, consequently, for many types of valuable goods, less economical than lapping. Rolling on boards is seldom adopted for jute fabrics, but is sometimes practised for linen fabrics, in which case the end of the piece is protected from damage and the convenience of the rolled form retained. Lapping is also the more convenient form for the temporary making up of goods, say in the loom state, which require to be rapidly loosened in order to pass through some further process such as piece bleaching or dyeing. Jute goods intended for such processes are usually transferred in the rough loose folds into which the piece is thrown by the faking board of the measuring machine.

Briefly stated, the operation of lapping consists of folding or doubling the cloth repeatedly upon itself in folds or laps which are approximately equal in length. These folds may vary in nominal lengths from about one yard in the linen trade to a maximum length of three yards for jute fabrics. Machines for the latter goods are constructed according to requirements for a maximum length of fold of 72, 90, or 108ins. and for practically any width of cloth. The medium size, or 90in. machine, is perhaps that most usually supplied, while a fold of 80ins. in length may be taken as a good average. In general, the length of the lap should increase with the weight of the cloth, and also with the length of the piece to be treated; or, in other words, with the difficulty likely to be experienced in the further making up.

Machine makers usually describe lapping machines by the more comprehensive title of "folding and measuring machines", but, although the machines are capable of indicating the number of folds, they are seldom employed for the purpose of measuring, unless the fold is exactly one yard in length, or some other simple and convenient unit This is the general practice in certain branches of the linen trade, the length of the lap employed being the ell of 37 ins. In the jute trade, however, where the working length of the fold may be varied at will, and often is varied to suit requirements, the value of the machine as a measurer is inconsiderable. Even assuming that each successive fold of the cloth is exactly the same in length, the mechanism, which is arranged to indicate the number of complete folds, takes no account of the length of the fold at that particular time, neither does it record the length pulled over by the attendant at the beginning, nor of the fractional part of the fold left at the finish of the piece. A calculation would, therefore, be always necessary to find the exact length of the piece lapped. Further, most of the machines in general use have tables of convex form, and it is not safe to assume that all the folds made by the machine are even practically equal in length, for, as lapping proceeds, the pressure of the grip rails at the extreme ends of the folds compresses the cloth there in such a manner that the pile of cloth folded is thinner at these edges than it is in the middle, where the pile of folds is free from any external pressure. This gradual thickening or arching of the pile of cloth in the centre prevents practical exactitude in the length of the folds, and the tendency to error increases in proportion to the softness of the goods. In practice this known defect may, for goods of a standard length and make, sometimes be compensated for by so arranging the travel of the folder that the average length of the folds in the pile will equal the

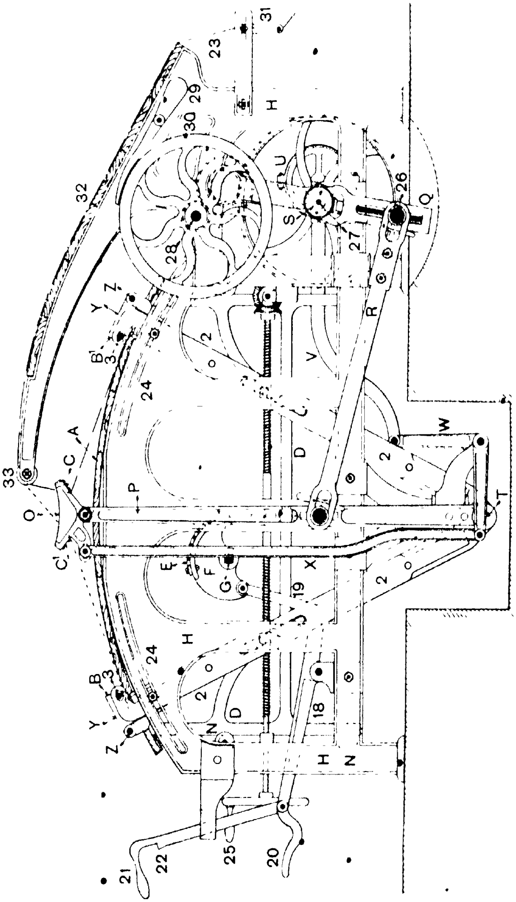


Fig 76

nominal length of the fold desired. Machine makers have also introduced concave tables with the object of correcting this defect ;

but so far as we have been able to ascertain, machines with concave tables do not seem to have been introduced into the jute trade, although several are in use in the linen branch. In such machines the table dips towards the centre of the fold, while the fold itself is formed by traversing the folding knives horizontally above the cavity of the table, into which the successive folds fall after they are formed and are released by the grip rails. With such an arrangement greater accuracy in the length of the different folds may be obtained where the lengths are comparatively short—the limits of one maker's machine are from 18 to 42ins., but the benefits of the method when applied to folds of much greater length are doubtful, and, we believe, have yet to be demonstrated.

As we have stated previously, the great bulk of linen piece-goods, especially those having a stiff finish, are lapped by hand, and, for obvious reasons, such a method, unless very carefully performed, is untrustworthy as a means of measurement. It is desirable, therefore, that measuring of all piece-goods should be done apart from lapping, and preferably on a machine which is specially constructed for that purpose.

Jute goods are usually lapped in the full width state unless specially ordered to be previously crisped to meet customers' requirements. Linen is frequently lapped in the crisped condition.

Lapping machines by different makers differ somewhat in details, but they are all practically alike in their essential features. That illustrated in Figs. 76 and 77 is the standard machine constructed by Messrs. Hacking and Co. Limited, Bury, for the jute trade. Fig. 76 shows the side elevation of a 72in. machine of this kind, while Fig. 77 is a sectional elevation of the same machine. The latter figure shows more distinctly the method of supporting the non-oscillating table A, and of operating the movable grip rails B and B¹ to permit of the entrance of the cloth between the grip rails and the table. Fig. 78 is also a sectional elevation, but it illustrates an older, although still largely used, method of supporting the lapping table and the apparatus which causes it to oscillate, or to fall slightly at the end of every lap or fold to make room for the folding knife C or C¹ to enter the cloth between the table and the corresponding fixed grip rail B or B¹. The method indicated in Fig. 77 is being adopted, however, in all the new machines. Referring first to Fig. 77, it will be seen that the table A is built upon, and supported near each end by, a cast-iron framework D. These frames D are in turn supported by flexible chains E attached to semicircular cams F. The cams F are affixed in suitable positions on the horizontal shaft G, the latter being carried by brackets not shown, but which are bolted to the framework H of the machine. The table A and the frames D are counterpoised and pressed upwards against the grip rails B, $B^1$ by the action of the spiral springs J acting through the scroll cams K, which are also fixed on the shaft G. Six pairs of springs are necessary for a 90in. table—about 100ins. wide,—but the graded form of the cam K tends to counteract the increase of pull imparted to the springs J as the table A is gradually depressed by the increase in thickness of the plies of cloth during the process of lapping. It is sometimes urged against the springs J that they are not so adaptable as weights (see 8, Fig. 78) for an increase or decrease of pressure to meet the cases of heavy and light fabrics respectively. Messrs Hacking and Co., Limited, have recently introduced an improved method of fixing the springs J—see detached

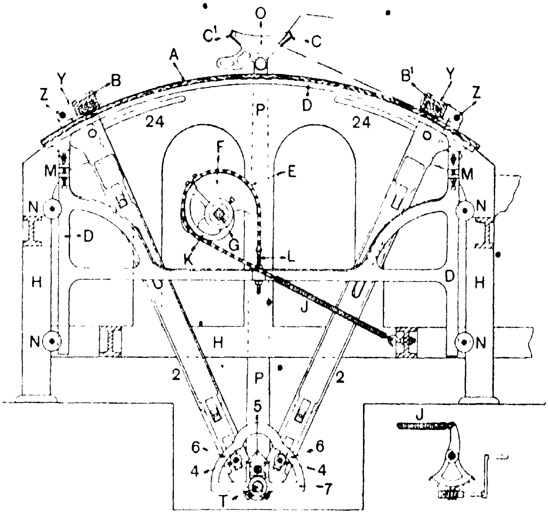


Fig. 77.

diagram at the foot of Fig 77—by which any degree of pressure may be obtained at will. We are not aware that this improvement has been attached as yet to any heavy lapping machine for jute cloth, but its introduction is no doubt a question of time. Satisfactory means of adjusting the height and level of the table are provided: the ends of the table may be adjusted at L (Fig. 77), and the sides adjusted at M, M by the set screws and lock nuts, while the framework of the table is retained in its vertical position and guided in its vertical movement by means of the flanged guide pulleys N, N.

The folding knives C and C¹ are rigidly fixed at each end to a trough-shaped carrier O, which is fulcrumed upon a stud in the upper end of the folding lever P (Fig. 76), and they are transported from side to side of the machine between the grip rails B and B¹ by the action of crank Q and connecting arm R as the hollow shaft S revolves. Folding lever P is suitably supported, and fixed at the lower end to the rocking shaft T.

As the lever P moves from right to left the knife C acts upon and draws forward the cloth (shown by dot-and-dash line) until the latter approaches the grip rail B, when, in order to facilitate the free entrance of the knife and cloth between the table and the grip rail B, the knife C is placed in a position parallel to the face of the grip, and close to the table or the last layer of cloth, by the upward movement of the knife C¹. This tilting action of the trough or knife-carrier is imparted by the eccentric U (Fig. 76), on the hollow shaft S, through arm V, bell crank lever W, and rod X, the latter being connected to a projecting bracket on the trough. When the trough is so tilted the knife C neatly places the cloth under the grip rail B, which is clothed on the underside with indiarubber or with wire card-clothing for the purpose of gripping the cloth and holding it firmly in position. The knife C rises during the return stroke, while in a similar manner to that just described, knife C¹ takes charge of the cloth, carries it across the table, assumes a position parallel to grip rail B¹, and then enters with the cloth between the grip and the table. These functions and changes of position of the folding knives C and C¹ are common to all lapping machines. In some machines of an older type, however, the eccentric U is dispensed with, the rod X is perfectly straight, and its lower end is centred upon a fixed stud approximately vertically beneath its point of connection with the carrier O when the latter is in the middle of its stroke. In such cases the tilting of the knives is due entirely to the change of position made by the various parts as the carrier moves from side to side. In some machines the oscillation or depression of the table A, to permit of the entrance of the knife and cloth beneath the grip rail, is accomplished by the folding knife itself, which is curved for this purpose. As the knife approaches the end of its travel its curved outer side is tilted towards the table, which it strikes and depresses from the grip rail so that the cloth may be entered.

The method of actuating the grip rails for the non-oscillating table illustrated in Figs. 76 and 77 is as follows:—Each grip rail B, B¹ in these figures is supported by two short arms Y, which may oscillate slightly about the central studs Z fixed in the stationary section of the double radial arms 2. Projecting from each arm Y is a small stud 3 which enters a corresponding slot in the upper end of the outer or sliding section of each radial arm 2. From the lower end of each sliding section a short stud projects through a guiding slot in the fixed section of each radial arm, and each stud carries an anti-friction roller 4 (Fig. 77). This roller is alternately raised by the nose 5 and depressed by the curved arms 6 of the oscillating cam 7 as the latter rocks in unison with the movement of the folding lever P and rocking shaft T. In this manner the grip rails B and B¹ are alternately raised to allow the folding knives to enter with a fold of cloth, and also alternately locked in position to retain the fold until the return of the folder with the next layer of cloth. When grip rail B is raised, B¹ is locked, and *vice versa*. A motion of this kind is preferable to the older oscillating-table motion illustrated in Fig. 78, and it is, moreover, much more easily operated.

In Fig. 78 the grip rails B and B¹ are fixtures for the time being, but as the folding knives C and C¹ approach the end of their stroke in either direction, the table A is slightly lowered at that end to permit of the cloth being entered by the operating knife beneath the grip rail. As the folding knife in action recedes and leaves the cloth, the table A and the cloth are pressed upwards against the card clothing of the grip rail by the action of the adjustable weights

8 on the lever fulcrumed on shaft G. On the same shaft, and near each end, semi-circular cams F are also fixed, from which flexible chains E depend to support the vertical rod 9, table frame 10, and table A. Similar flexible chains E, attached to flanged pulleys 11 on shaft G, are first passed over pulleys 12, centred at each side of the table frame, then over further guide pulleys 13, and are ultimately attached to square slide rods 14. These rods are suitably

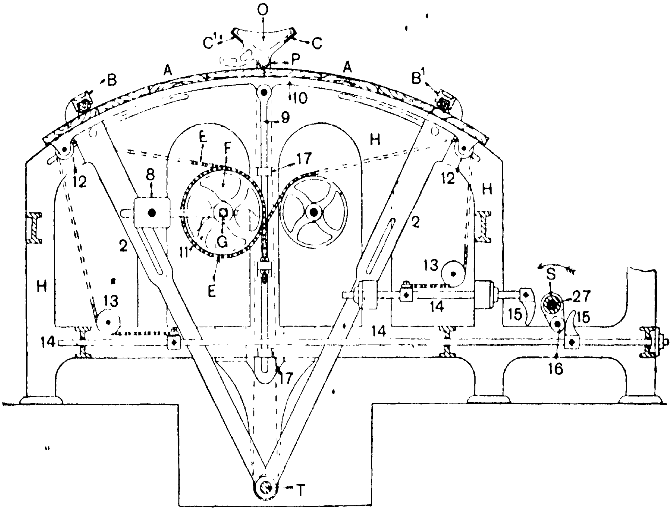


Fig. 78.

supported by the framework of the machine, and each rod is furnished with a projecting shoe 15 which interposes in the path of the anti-friction roller 16 as the latter revolves with the hollow shaft S. As shaft S revolves, roller 16 acts alternately on each shoe, and in this way causes each slide rod to make an endlong movement away from the shaft; each slide rod in turn thus shortens the reach of chain E between two adjacent pulleys 12 and 13, and so pulls down the table A at that end. When this occurs at one side, say the right hand, the left hand edge of the table acts as a fulcrum by pressing against the grip rail B, and *vice versa* when the table is lowered at the left hand. In both cases, while the table is being lowered, the vertical rods 9 dip slightly in the guiding slots 17, which are situated on the inner side of the framework. Immediately a shoe 15 is released by the removal of rotating anti-friction roller 16, the weights 8 react upon the table to raise it again to its normal position, and to return the slide rod 14 and shoe 15 into the path of the revolving cam.

All lapping machines are provided with means whereby, when the lapping of a piece is finished, the table may be depressed against the action of the springs J (Fig. 77) or the weights 8 (Fig. 78), to permit of the removal of the pile of folded cloth. In Messrs Hacking and Co.'s machine this part usually consists of a lever 18 and link 19 (see Fig. 76), so connected to the cams F on the shaft G that foot and hand power may be applied by the operative, at points 20 and 21 respectively, to counteract the force of the springs J or the weights 8, and so permit the table and the lapped piece to move downwards. A retaining shoulder 22 is also provided to keep the table in the low position until the starting end of the next piece is entered.

All modern machines are furnished with apparatus by which the length of the fold may be quickly and accurately altered and the distance apart of the grip rails contracted or expanded to suit the new length: this provision is also shown in Fig. 76. Radial arms 2 are centred on shaft T, and each arm is provided with a longitudinal slot towards its upper end. Situated immediately behind the slots in the arms, and at each end of the machine, is a heavy right and left hand screw, each thread of which carries a loose or travelling brass nut; a short stud projects from each nut and enters the slot of the corresponding arm. By slackening the fixing bolts in the concentric slots 24 of the framework, and rotating the hand-wheel 25 in the proper direction, the radial arms and their grip rails may be closed or opened to any distance within the limits of the machine. Both screws are connected by the bevel gearing indicated, so that the radial arms at each side of the machine may move in unison.

Somewhat similar provision is made for the corresponding alteration in the length of the traverse imparted to the folding knives C and C$^1$. Each crank arm Q carries a screw which controls the position or working radius of the crankpin 26. Both screws are connected by bevel gearing and controlled by a smaller shaft 27 (see also Fig. 78) which passes right through the hollow shaft S, and is operated by an auxiliary handle not shown. This handle engages with the shaft 27 by means of two pins which enter corresponding holes in a disc keyed to the extreme end of the shaft.

The gearing for operating the machine is perhaps sufficiently well indicated in Fig. 76. The fast and loose pulleys are situated on the shaft 28 at the opposite side of the machine, while the shaft S is driven through wheel and pinion gearing of the following values: Spur pinion of 22 teeth on shaft 28; intermediate wheel and pinion of 45 teeth and 22 teeth respectively, spur wheel of 124 teeth on shaft S. The pulleys on a 90in. machine may run at 186revs. per minute, giving a folding speed per minute of:—

$$186\text{revs.} \times \frac{22}{45} \times \frac{22}{124} = \text{approximately 16 double folds or}$$
$$\text{32 single folds per minute.}$$

The belt fork rod is usually arranged so that it automatically removes and replaces the brake 29 on the fly or hand wheel 30, at the start and at the stoppage of the machine respectively. It is desirable to keep the folding lever P in an approximately vertical position when the machine is at rest.

Figs. 79, 80, and 81 are three diagrammatic views showing the positions of the folding knives C and C$^1$ at the centre of their stroke and at the extreme points of their travel. They show in reality only half a revolution of the crank and eccentric shaft S, but they illustrate practically a complete cycle of movements of the folding knives. In Fig. 79 the folding knives have been carried to their extreme position on the left, and the knife C has just placed a fold of cloth under the left-hand grip rail. In Fig. 80 the knives are moving to the right and are about midway in their travel, with knife C$^1$ in charge of the cloth—a position similar to that shown in Fig. 76. Finally, in Fig. 81 the right-hand extreme position is shown, with knife C$^1$ placing the cloth in position under the right-hand grip rail. The grip rails have been omitted in these diagrams for the sake of clearness.

Lapping machines of this character are sometimes utilised in the jute trade for the purpose of doubling up the cloth into folds of a predetermined length previous to cutting up for sack-making. When this function is desired the crown of the lapping table A must be provided with a slot, along which a knife may be run to

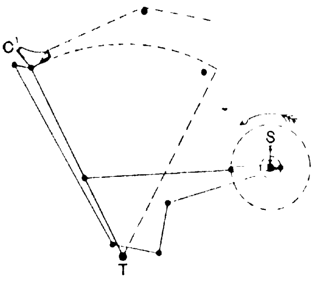


Fig 79.

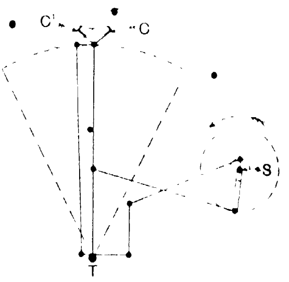


Fig 80.

cut through the folds of the cloth; in addition, a slotted clamp has to be arranged to coincide vertically with the slot in the table. When the folding is completed, the clamp is lowered on to the top layer of cloth, thus securing the whole piece and holding it firmly while the knife is passed from side to side. The knife, which naturally passes through both slots, severs the plies of cloth in its passage, and leaves a pile of folded lengths of cloth on each side of the table. These lengths are then ready for sewing, or for branding or stamping previous to sewing. When a lapping machine is used for this purpose, the table edge is invariably marked in inches or half inches for convenience in adjusting the grip rails the proper distance apart, and for setting the travel of the folding knives to suit.

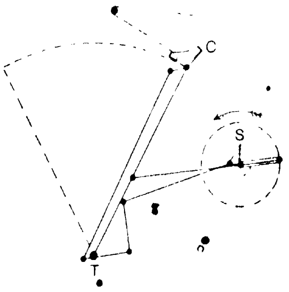
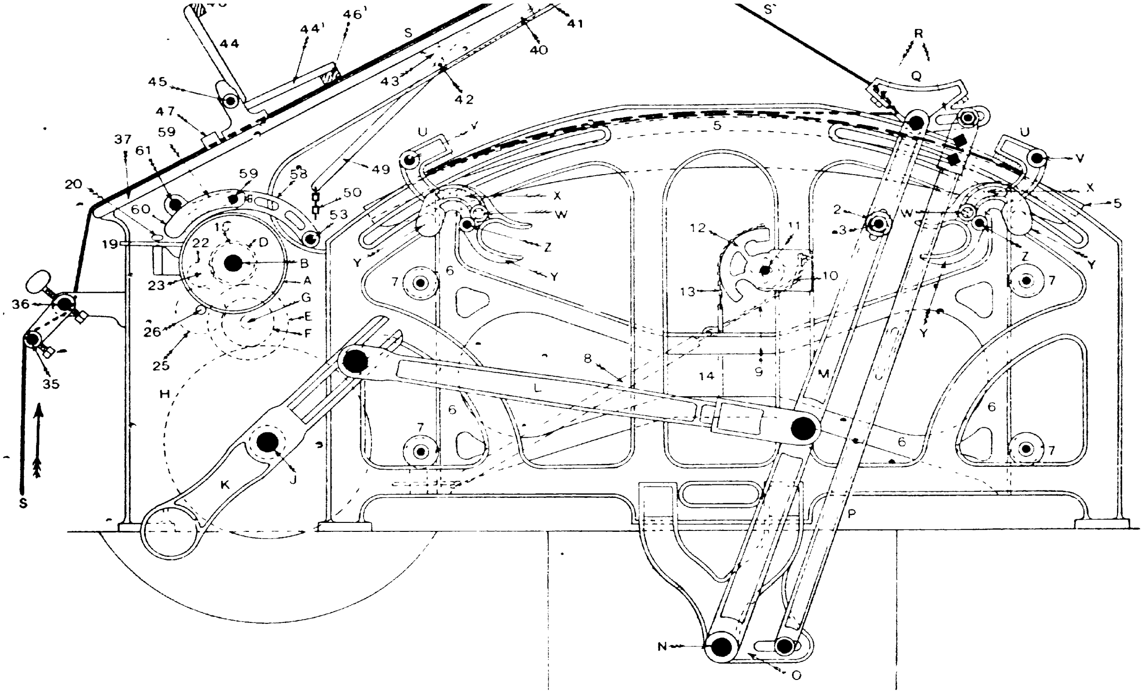


Fig 81.

The general procedure of lapping, and the usual method of operating the machine, may be described as follows:—The piece to be folded is brought from the measuring machine in loose folds, and is placed upon a low table, or upon a low wooden platform in front of the machine—that is, on the right-hand side of Fig. 76. The attendant passes the cloth over and under the tension rails 31, over sight-board 32 and roller 33, then between the knives C and C¹. Lever 20 is then pressed down until catch 22 holds the table firmly, and clear of the grip rails B and B¹. The end of the cloth is then drawn between the grip rail B and the table until a sufficient length, say two or three yards, is obtained for wrapping. The lever 21 and catch 22 are now withdrawn, when the table rises and grips the piece securely. The belt, is moved on to the fast pulley, and the machine commences to fold the cloth as already described. A star wheel on the shaft S, and further suitable connections, are provided to register the number of folds on a clock face, but this part of the mechanism is usually neglected, because the number of folds is of little practical value, except for some purpose such as the above-mentioned method of making sack lengths.

While the piece is being folded, other operatives are engaged making up the previously folded cloth on a making-up table, and immediately the new piece is folded, this table, which is usually on castors, is brought quite close to the back of the machine. The length of cloth intended for wrapping purposes is first thrown along the making-up table, lever 20 is depressed until catch 22 is in position, and the folded piece is then pulled from the lapping table on to the one for making up. On this flat table the piece is now wrapped or doubled up into a number of thicker folds, which vary in form according to the length of the original lap. With a long lap, say of three yards, the ends of the piece of cloth are first placed neatly in the middle of the lap, the extreme edges of the folds are now brought to the centre, then each is doubled again, and, finally, one group of folds is doubled on the top of the other. The neatly wrapped piece is now tied at both ends, and at one or two intermediate places to prevent it from coming loose. The length in yards of metres, the breadth in inches or centimetres, with perhaps a quality number and some private mark, are stamped or stencilled on the piece, which is now ready for packing. The finishing operations of lapping are always performed by hand, and they require considerable skill and dexterity on the part of the lappers.

Figs. 82 and 83 illustrate side elevation and plan of a unique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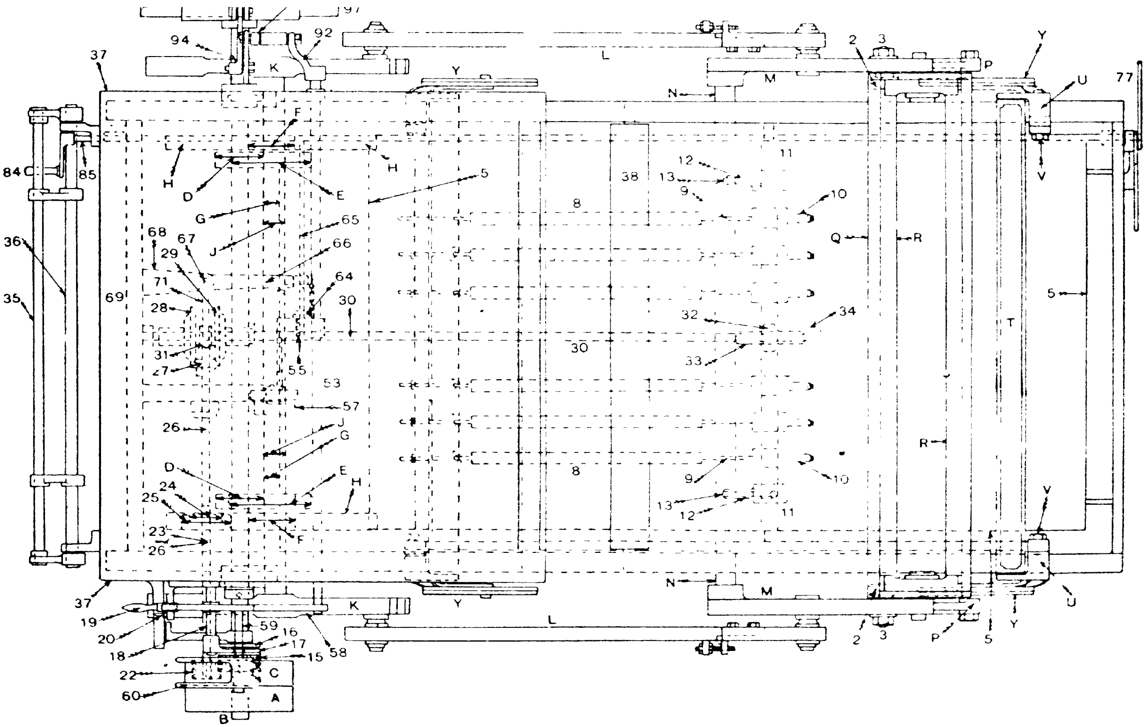

Figs. 82 and 83.

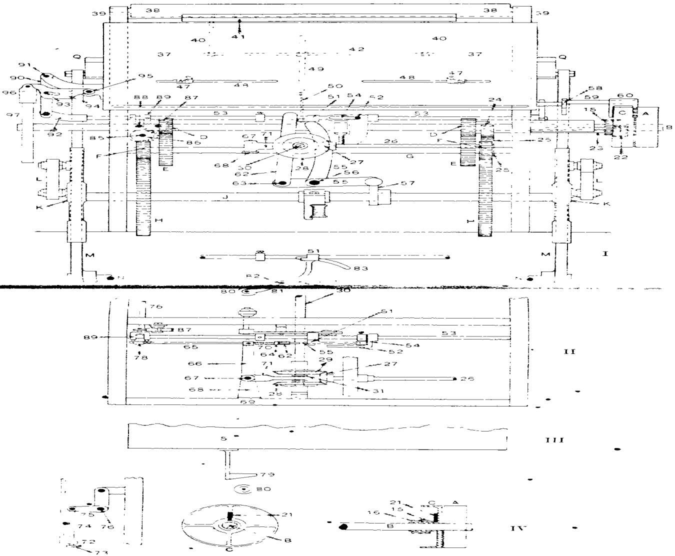
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Fig. 84.

folding machine made by Messrs Geo. Hattersley & Sons, Ltd., Keighley, while Fig. 84 is a part sectional elevation from the feed side, together with a few details of the internal mechanism. The positions of the pulleys of this machine differ from most others in that the fast pulley A is on the outside and near the end of the driving shaft B, while the loose pulley C is on the inside between the fast pulley A and the outer frame. Inside the framework and fixed on shaft B, which passes through to the other side, are two pinions D driving compound wheels E and F on shaft G. The pinions F drive two large wheels H on the low shaft J. The usual balanced cranks K on shaft J, one at each side of the machine, are provided with the apparatus for adjusting the connecting arms L with respect to the desired throw, and the connecting arms L are attached also to the long levers M fulcrumed at N in brackets O. In a slot in the same bracket O for adjustment is fulcrumed the rod P, and both M and P are attached as shown to the oscillating knife carrier Q. The movement of these or similar parts has already been described in connection with Figs. 76 to 81, but the lettering is different. One of the knives R, the left one in Fig. 82, is shown carrying the cloth S towards the right of the machine in order to place the cloth under the grip rail T (Fig. 83), which is operated as follows: The grip rail support and lever U (Figs. 82 and 83), is fulcrumed at V, and its lower arm carries a pin W which enters the slot X in the companion bracket Y fulcrumed at Z. An anti-friction bowl 2 is carried by a stud 3 in the lever M, and when this bowl is nearing the end of its stroke at either end, it enters the recess or forked end of lever Y and partially rotates the latter—counter clockwise on the right lever and clockwise on the left. The slot X is not concentric with the fulcrum Z, and hence when the lever Y turns upon its fulcrum Z, the slot X moves downwards and forces the pin W further from the fixed fulcrum Z. It therefore follows, that both arms of lever U, fulcrumed at V, are raised. The short arms of levers U carry the grip rail T, and hence the pins of the grip rail are lifted in time to allow the knife and the cloth to pass under. When the knife returns, the weighted end of lever Y returns the pins of grip rail T to the cloth.

The cloth is thus lapped or folded on the top of the table 5, the supports 6 of which are guided in their vertical movements by the grooved pulleys 7. The usual springs 8, chains 9, and cam 10 serve to press the table upwards. The cams 10 are placed on the square shaft 11, and so are the two segments 12 which carry chains 13 attached to short rods 14. These rods pass through projections at the bottom of the frame 6.

One of the main features about this machine as compared with others is that the table 5 is governed automatically and thus relieves the attendant of a considerable amount of hard work. On the main shaft B, and between the loose pulley C and the framework, is a wheel 15 and clutch 16 compounded, the clutch being shown only in Figs. 83 and 84. A clutch fork 17 is carried by the short shaft 18, and this shaft is operated by handle 19. A pin 20 is used to keep the handle in the desired position On the inside of the loose pulley C, which is shown in section in part IV. (Fig. 84), is fixed a rectangular piece of raw hide 21. The pulley C is naturally in motion when the machine is off, and if the clutch wheel 15 is forced towards the inside of the pulley C, a projecting pin on the face of the wheel is caught by the raw hide piece 21, and hence wheel 15 is rotated. Wheel 15 then drives wheel 22 on shaft 23. On the same shaft 23, but on the other side of the framework, is a pinion 24 which drives wheel 25 on shaft 26. On the end of shaft 26, and near the middle of the machine, is a bevel pinion 27 which drives two larger bevel wheels 28 and 29 running loosely on the free wheel shaft 30. A clutch 31, shown in detail II. (Fig. 84), and in its central or inoperative position, can be placed into gear with either wheel 28 or wheel 29, and thus drive the free wheel shaft 30 in either direction as desired. Near the other extreme end of the shaft 30 is a worm 32 which drives the free wheel 33 on the square shaft 11, while at the extreme end is a hand wheel 34 for hand manipulation. The object of this mechanism is to lower the table 5 automatically as soon as the end of the cloth has passed over the sight-board 37. When the machine is not in use and the loose pulley running, the above mechanism can be stopped by withdrawing the clutch 16 and wheel 15 by the handle 19, and inserting the pin 20 in the position shown in Fig. 83; but when the machine is in work, the clutch and wheel are placed in gear and the handle 19 is on the other side of the pin 20 to that shown in Fig. 83, and then all the automatic mechanism up to the wheels 28 and 29 is in motion, but the lapping or folding mechanism is at rest because the belt is on the loose pulley C. These are the conditions which obtain when the operative commences to introduce the cloth S. The end of the latter is first passed through two tension rails 35 and 36 then thrown over the sight-board 37, over guide roller 38 in bracket 39, and between the knives R of the oscillating part Q. Sufficient length for wrapping is drawn forward between the table 5 and the grip rail T and on to a large fixed or movable table near the delivery end of the machine. At this time the table 5 is in its lowest position, but if for any reason the table is up, it may be lowered by the automatic mechanism in order that the cloth may be introduced as stated.

Two arms 40, one near each side of the sight-board 37, support a wooden bar 41. These two arms are fulcrumed on a rod 42 supported by brackets 43 screwed to the underside of sight-board 37. When the cloth has been drawn through as stated, it presses wooden bar 41 into a slot in the sight-board and flush with the face, and in order that the cloth may be kept taut and thus keep the wooden bar 41 in the slot, two arms 44, one on each side of the sight-board and fulcrumed at 45, and carrying a wooden bar 46, are swung down until the bar 46 rests on the cloth as shown at $46^1$. Two sets of guides 47, one set only shown, and adjustable in slots 48, serve to keep the cloth centrally situated and in its proper position. On the rod 42 (Fig. 82), is also placed a lever 49, to the lower end of which is attached a chain 50, which in turn is attached to and supports the weighted end of arm 51, fulcrumed on stud 52, see detail view II. (Fig. 84); the stud 52 is fixed to the set-on rod 53, and is capable of moving in the slot of bracket 54.

When the machine is empty, the wooden bar 41 is kept in its highest position, *i.e.*, projecting through the board 37 as indicated by $41^1$, in virtue of the weighted arm 51, but when the cloth is stretched over the board 37, the wooden bar 41 is pressed down flush with the face of the board as stated, and hence the end of the weighted arm 51 is raised just clear of the upper part of the L-shaped lever 55, fulcrumed at 56.

On shaft J is keyed a cam 57 which raises the short horizontal arm of lever 55 and oscillates the long vertical arm every revolution of shaft J. When the cloth is on the sight-board 37, the upper end of the long vertical arm of oscillating lever 55 can pass freely under the raised weighted arm 51, but when the end of the cloth leaves the sight-board, the wooden bar 41 is liberated, and the weighted end of arm 51 naturally drops in front of the upper end of the vertical arm of lever 55. As the latter moves to the left, its end comes in contact with, and carries the weighted arm 51 to the left; and, since the latter is connected to the set-on rod 53 by the stud 52, it follows that the set-on rod will also be taken to the left. On the extreme end of shaft 53 is a bracket 58 (Figs. 82 and 83), and from this bracket projects a short rod 59 to which the belt fork 60 is set-screwed. It will thus be seen that when the set-on shaft 53 is moved to the left, the belt will be moved from the outer or fast pulley A to the inner or loose pulley C; during this movement the bracket 58 slides on a short guide rod 61. The loose pulley C is consequently put into motion, and so are all the parts 15, 22, 23, 24, 25, 26, 27 and the two bevel wheels 28 and 29. At the same time the left hand part of the weighted arm 51 is pressed against the upper end of lever 62, fulcrumed at 63. The lever 62 ultimately comes in contact with a collar 64 on rod 65 (*see* II. Fig. 84). The rod 65 passes through a hole in the head of a stud, and the thin part of the stud enters a slot at the end of lever 66, fulcrumed at 67; the latter is a stud which rises from the bracket 68 on the cross rail 69. It will be seen that when the lever 62 forces the collar 64 to the left, part of this movement is taken up by compressing the spring 70, and the remainder by moving the arm 66 and the clutch fork 71. The latter movement places the clutch 31 in gear with the bevel wheel 29. Hence the latter drives clutch 31, shaft 30, worm 32 and worm wheel 33 on the square shaft 11. The square shaft rotates counter-clockwise (see Fig. 82), and lowers the table 5 automatically until a projecting part 72, see IV. (Fig. 84), of the table support 6 comes in contact with a collar 73 on the vertical rod 74. This rod is attached to a short lever 75 fixed on shaft 76. At one extreme end of shaft 76 is fixed a handle 77 (Fig. 83), and at the other end is a crank 78 (*see* II. Fig. 84), attached to rod 65. Immediately the projecting part 72 (*see* IV. Fig. 84), reaches the collar 73, it is clear that the lever 75 will begin to move and to rotate slightly the shaft 76, while at the same time the crank 78 will move rod 65 a little to the right. This causes the levers 66 and 71 to withdraw the clutch 31 from the bevel wheel 29, and thus the downward movement of the table 5 is arrested.

Another projection 79, underneath the table 5 at the feed side, comes into contact with bowl 8 as the table descends. This causes lever 81, fulcrumed at 82, to rotate counter-clockwise and its long curved upper arm 83 raises the weighted end of arm 51 to allow the lever 62 to move forward to its normal position.

The lapped or folded cloth is now drawn from the table 5 to the fixed or movable table, not shown. Another cloth is then entered as already described, and the table 5 raised to its highest position in the following manner: Handle 77 (Fig. 83), is moved slightly counter-clockwise, and so also is shaft 76; the partial rotation of the latter results in the clutch lever 71 being moved still further in order to place the clutch 31 in contact with the bevel wheel 28, and thus enable the latter to rotate clutch 31, worm 32, free wheel 33 and square shaft 11 clockwise (*see* Fig. 82). The square shaft, through segments 12, will clearly raise the table 5 to its highest position. The operative keeps the handle 77 up while the table is ascending, but immediately he releases the handle it is forced into its normal position by a spring hammer. The table is prevented from rising too high in consequence of the action of the free wheel; the latter slips on the shaft if the operative has not released the handle 77 by the time the table 5 reaches its highest position.

When all is ready for folding the next piece, the handle 84 is moved counter-clockwise rotating shaft 85 and segment wheel 86. The latter rotates segment wheel 87 clockwise, and a pin 88, projecting from the face of segment wheel 87, enters a forked bracket 89 which is set-screwed to set-on shaft 53. This movement carries the belt on to the outer or fast pulley A, and simultaneously it causes the lower end of lever 90, fulcrumed at 91, to be moved to the right by the connection 92 to shaft 53. A pin 93, projecting from the side of the lever 90, and entering a swan-neck slot in the lever 94, fulcrumed at 95, raises the lever 93, and the latter in turn lifts the brake 96 clear of the brake wheel 97. When the belt is moved to the loose pulley C, the same parts naturally apply the brake to the brake wheel 97.

For a considerable period all lapping machines were alike in respect that they were each provided with a convex table, and that the folding knives moved in a semi-circular path, and plaited the cloth in folds or laps which were more or less convex in form. But, as we have already pointed out, this form is not conducive to, nor can it be depended upon in practice to give, accurate results as regards the measurement of the successive folds of cloth. Now, in certain sections of the linen and other trades, a common practice exists of lapping the pieces in folds of a regulation length of 37in., or of some other suitable unit, and of utilising this length as the usual unit of measurement and of sale. This somewhat extensive practice has gradually created a demand for a machine which could be depended upon to give more accurate measuring results than the ordinary semi-circular or convex table could be expected to give; machine makers have therefore introduced, within recent years, modified types of lapping machines to achieve this end. Machines of this newer and modified character are usually fitted with tables of a flat or of a concave form; they make the laps or folds more or less horizontally, and naturally possess certain modifications in their mechanism to meet these essential changes from the circular and probably more natural method of producing a mechanically lapped or folded piece.

Messrs Hacking and Co.'s folding and measuring machine, with semi-concave table as used in the linen trade, is illustrated in Figs. 85, 86, and 87, which show respectively side elevation, part sectional elevation, and part plan As will be seen from Figs. 85 and 86 the new form of table is made in two parts A, A, which are supported as before on a frame B; the tables are hinged as shown about their inner edges, and are inclinable inwards to any practicable degree, so as to give what is practically a concave form. In each of these two figures is shown a different method of regulating the degree of inclination which may be given to suit cloths of different natures, thicknesses, and lengths. In Fig. 85 rotatable pantagonal blocks, partly in solid black and partly stippled, or supports C are shown—the sides of the pentagon being at different distances from the axis of rotation,—while at C, in Fig. 86, another method of fixing the table is indicated; a method which may be used in conjunction with suitable setting screws or sliding wedges.

In both figures the table A and table frame B are shown in their low position, but under normal working conditions they are pushed upwards by the action of the weighted levers or of springs D, so that the higher edges of the folded pile of cloth may bear against the under side of the grip rails E, $E^1$. Springs D in this case are attached by one end to the chains F, and by the other end to short levers M. The chains F are fixed to the scroll cams G, mounted as shown on the square shaft H, while the shaft H is supported by

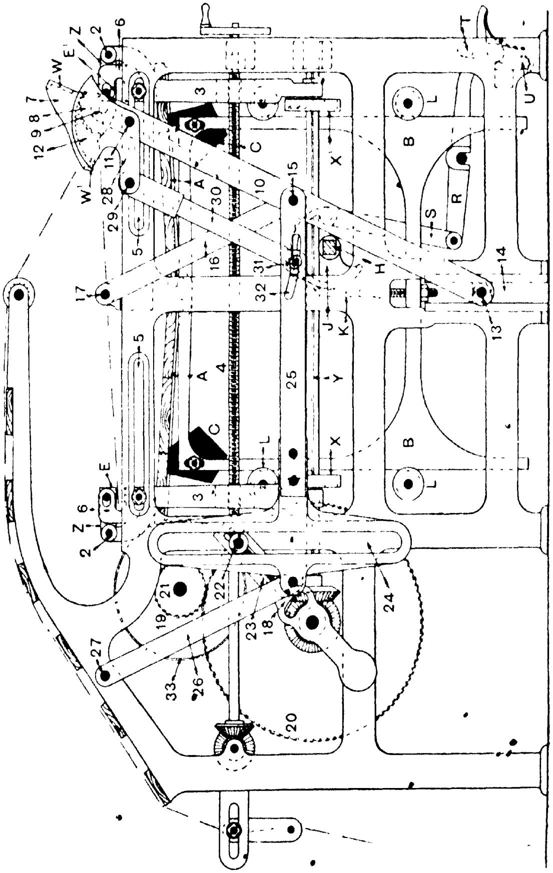


Fig. 85

suitable brackets, and carries, near each end, a semi-circular cam J, from which other chains K are connected to the table carrier B (*see* also the plan Fig. 87). As in the machine previously described, the table carriers B are guided vertically by suitable flanged pulleys L. The short levers M, which are keyed to the shaft N, may be moved to the left or right by means of the hand wheel O, worm P, and sector Q, so that the tension on the springs D may be weakened or strengthened. It is often necessary to distend the springs slightly to increase their tension and power of upward pressure on the table for cloths of a heavy character.

The table of this machine is depressed against the pull of the springs (six of which may be mounted on a 56in. table) by a treadle lever R, connected by a link S to one of the curved levers or cams J. A swinging catch T is fulcrumed to the treadle itself, and when the latter descends, the catch automatically engages with the curved part of U, and being thus hooked it prevents the return of the table until it is released by the attendant. The release of the catch T takes place simultaneously with the downward pressure of the treadle by the foot of the attendant, who has thus complete command over both, and, consequently, of the upward motion of the table.

The grip rails E, E¹ are alternately and intermittently lifted to permit of the entrance of the folding blades W, W¹ by means of the positive cams X, X¹ mounted upon the slotted shaft Y. The grip rails are carried on brackets Z, hinged at 2 to the outer section of the vertical carrier 3. The latter, and therefore the grip rails and cams X, X¹, may be slid simultaneously to or from each by means of a hand wheel and the right and left hand screw 4 and suitable nuts on the carriers 3, so as to serve for the different lengths of fold required within the limits of the machine, 18 to 42 in. When set for a desired length of fold all the parts are secured in position by bolts passing through the slots 5 in the framework. Cams X, X¹ engage with shaft Y by means of a sliding key, and as Y rotates they impart an intermittent lifting motion to the section 6 of the vertical carrier 3, and thus raise bracket Z and the corresponding grip rail. Cams X, X¹ are so set on the shaft Y that their swells oppose each other and therefore lift the grip rails E, E¹ alternately. The folding blades W, W¹ of this machine are at each end mounted on an oscillating trough-shaped carrier 7, which is cast with a toothed segment 8. Carrier 7 and segment 8 are journalled at 9 to the extreme end of side arm 10. On this side arm there is also journalled at 11 an internally toothed segment 12, which engages with the teeth of the segment 8. The side arm 10 is itself journalled on a stud or block 13, which is free to slide up

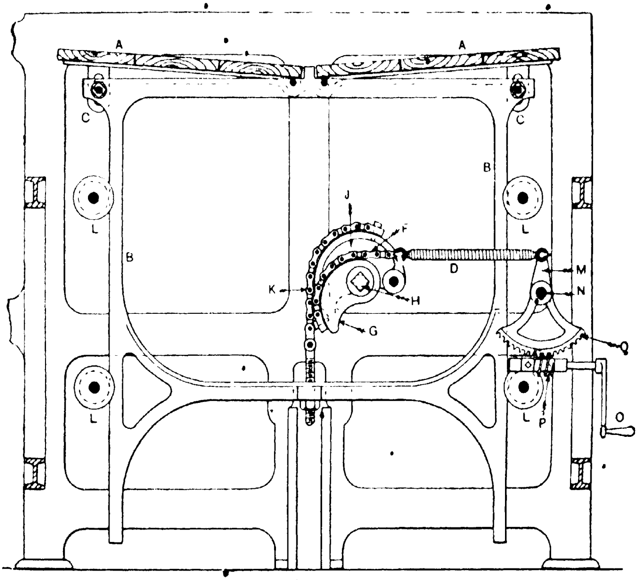


Fig 86

and down in slot 14, but is incapable of lateral or rotary movement. The side arm 10 is also hinged at 15 to a radius rod 16, having a stationary fulcrum at 17 on the machine frame. As the side arm 10 swings about its fulcrum 13 it carries the folding blades from side to side, but during this movement the lower end of the radius rod 16 describes an arc of a circle, causes the stud 13 to slide down the slot 14, and consequently prevents the upper end of 10 from rising. The folding blades have therefore a rectilinear or horizontal path.

The movements of the folding blades are derived from the crank 18, while the latter is driven by gear wheels indicated by the double dotted lines 19 and 20 from the main driving shaft 21. The crankpin 22 is mounted in a slot 23 in the crank, and by means of an enclosed screw the effective radius of the crank may be varied to suit different lengths of fold. The crankpin 22 engages with a transverse slot 24 in the connecting rod 25. The latter is hinged at one end at 15 to the side arm 10, and to the radius rod 16, and at the other end is hinged to a second radius rod 26, having a fixed fulcrum 27 on the machine frame. Radius rods 16 and 26 are, naturally, of equal length, and are parallel to each other; they suspend and guide the connecting rod 25 and the side arm 10, while the carrier 7 moves the blades from side to side of the machine.

The tilting of the blades W, W$^1$ in this machine is accomplished by toothed segment 12 gearing with and rotating segment 8 on the carrier 7. Segment 12 has an arm 28 which extends sideways, and is hinged at 29 to a controlling rod 30. The latter is fulcrumed on a stud 31, which can be secured at any desired point in the curved slot 32 in connecting rod 25.

When the machine is set to its maximum lap the arm 28 of the internally toothed segment 12 maintains, approximately, a horizontal position from end to end of the stroke; but the centre 9 of the toothed segment 8 is carried, by the angular movement of the side arm 10, relatively around the centre 11 of the internally toothed segment 12 for a portion of a revolution; segment 8 therefore obtains, from its contact with the teeth of segment 12, sufficient angular displacement for the purpose of tilting blades W, W$^1$ into the horizontal position. Since, however, the angular displacement of the toothed segment is independent of the length of the stroke, and must be the same for all lengths of stroke, it follows that some means must be provided for imparting an increase of movement to 8 which will counterbalance or compensate for the decrease occasioned by the reduced stroke of arm 10. The necessary degree of movement can be obtained by moving the stud 31 to its proper position in the long curved slot 32.

The ratio of gearing of the segments 8 and 12 is so arranged that when the machine is making folds of maximum length the requisite angular displacement is obtained by fixing the stud 31 at such a point that the controlling rod 30 and the side arm 10 are parallel, and the arm 28 of the internally toothed segment 12 thereby also parallel to the connecting rod, and therefore horizontal throughout its stroke. In order to obtain an equal angular displacement for shorter strokes or folds, the stud 31 is pushed away from the side arm 10 in a path which is the arc of a circle, the radius of which is equal to the length of the controlling rod 30, and its centre the upper axis 29 of the controlling rod when the side arm 10 is in its mid position. When the stud 31 is fixed at the extreme end of the slot farthest from the side arm 10, the arm 28 does not maintain a horizontal position but is alternately moved up and down in such a manner as to give the required additional movement to the toothed segment 8 and to the blade carrier 7. The transverse slot 24 of the connecting rod 25 is important as providing a means for overcoming a defect hitherto existing in all lapping machines having a side arm such as 10 actuated by a crank.

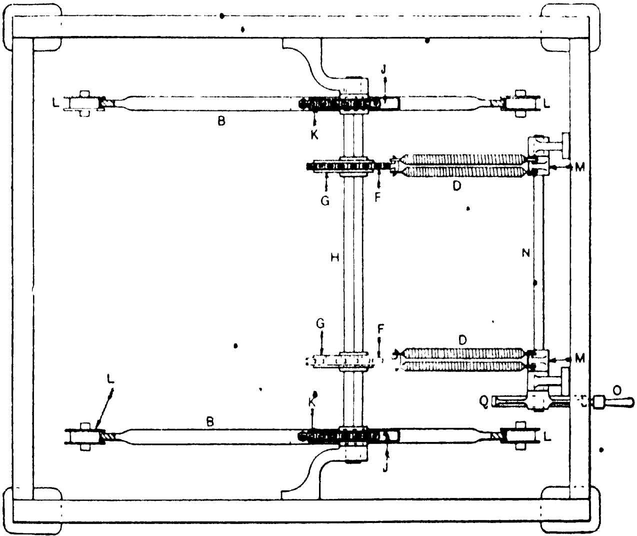


Fig 87

The grip rails E, E$^1$ have a uniform motion, and always descend at the same relative times whether the blades are making a long or a short stroke. But if the throw of the crank be altered, without also altering the length of the connecting rod, the arrival of the folding blades at the end of their stroke will no longer coincide with the descent of the grip rails. This defect in the timing of the movements could be remedied by adjusting the length of the connecting rod for each separate length of fold, but such a procedure would be very troublesome. By the use of the transverse slot 24 an automatic compensation is provided which overcomes the defect referred to in such a way that the side arm 10 is always in its mid position when the crank is in the middle of its stroke, and, consequently, the arrival of the folding blades at each end of their stroke will always coincide with the downward movements of the grip rails, no matter what may be the throw of the crank. Such a motion may, with slight modifications, be applied to a machine having the ordinary circular or convex table. Motive power is conveyed by belt to pulleys 33, which make approximately 190 revs. per minute, and the ratio of gear wheels 19 and 20 is such that shaft 21 makes nearly 2½ revs. for one fold.

# CHAPTER IX

## PACKING

WHEN the goods are finally made up in the condition required —rolled or lapped, or, if bags, sewn and bundled—they are ready, so far as the finishing and making-up operations are concerned, for distribution to the various parts of the globe; their destination, however, determines in some measure the particular method of packing which must be adopted. If the fabrics, bags, etc., require to be delivered within a radius of a few miles, they may not be packed at all, but simply placed on a lorry or cart, covered up with a wrapper, and despatched in this way to the purchaser. Large quantities of goods intended for the home market, wherever situated, are also delivered in the loose condition. When, however, there is a possibility of the goods being handled often, it becomes necessary to make better provision to ensure their safe arrival in good condition. In other words, the pieces or bundles must be covered up with some form of jute wrapper, termed a pack sheet, compressed into a comparatively small bulk if for export, and securely bound so that there is little chance of the material being soiled or damaged, and further that, for economic reasons, the space occupied by them will not be too great. Extra protection from soiling and damage by water is often provided by means of paper and waterproof linings of various kinds between the pack sheet and the goods enclosed.

The operation of packing the goods into a bale is invariably carried out in some form of press; a few of the simpler type are still operated by hand, but by far the larger number of these presses are worked by hydraulic power, hence they are usually called "hydraulic presses." The pressure per square inch exerted on the ram in these presses depends partly upon the class of goods, partly upon the way they are made up, and partly upon the

Fig 88

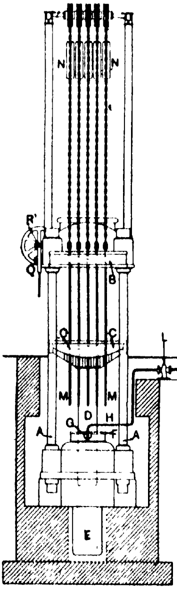


Fig 89

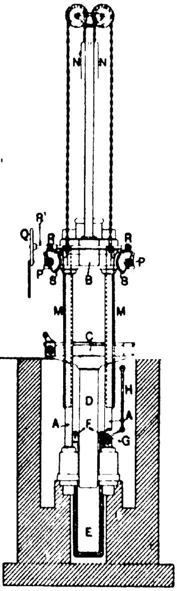
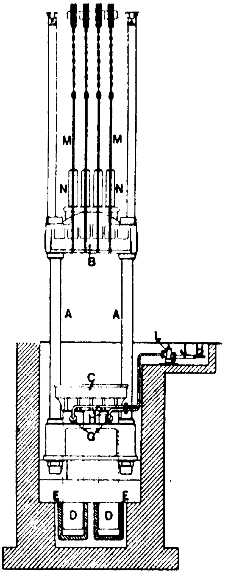


Fig 90.



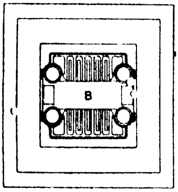


Fig. 91

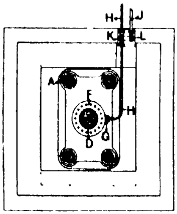


Fig. 92.

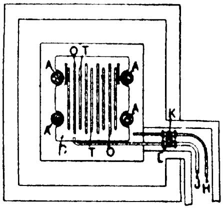


Fig. 93.

destination of the bale. Thus, the pressure may be from 8 to 10cwt. per square inch for home goods, but for export a pressure up to 30cwt. per square inch, or even higher, may be necessary, indeed, since it is essential that the bales for export should occupy a minimum of space in the hold of the vessel freight being charge by cubic measurement of 40 cub ft. per ton -- the pressure applied is generally as high as is consistent with the prevention of damage to the material In order to meet all cases of emergency, the cast steel cylinders of the modern hydraulic presses are made to withstand a test of three tons per square inch.

All modern hydraulic presses possess several parts in common; they differ only slightly in detail, but they are all arranged to perform the complete process of baling. Figs 88 to 93 inclusive illustrate various parts of modern hydraulic presses made by Messrs Urquhart, Lindsay & Co. Limited, Dundee. Figs. 88 and 89 are respectively front and end elevations of an 18in. single ram press, while Fig. 90 is a front elevation of a 17in. double ram press. In odd cases three rams are used. Fig. 91 is a plan of the top plate; Fig. 92 is a sectional plan of the four uprights and the ram, and it also shows the cover plate and the low supports; while Fig. 93 is a plan of the moving table. It is naturally essential that these presses should be well and strongly made in order to resist the enormous pressures which obtain during the working, consequently, the four heavy columns A, A, A, A, which support the massive top plate B, are securely and rigidly fastened to the concrete base and to the plate B. The lower plate or moving table C is fixed to the upper part of the ram D, which moves up and down in the cast-steel cylinder E. This cylinder is made tight by means of packing and a ∩-shaped leather washer, which is held securely by the cover lid F. The stream of water for pressure is admitted at G through 1¼in. bore pressure pipes H, and it will be evident that in proportion as the cylinder E is filled with water under pressure, the ram D and table C will be made to rise, being guided in this movement by the four columns A, along which the table C slides. It will thus be seen that as the table approaches the top plate B, the goods, which are carried up by the table, will ultimately come in contact with the top plate, and any further upward movement of the table will result in pressing the goods more closely together.

This is really the sole object of the apparatus; but while the operation of pressing is proceeding, it is necessary that the material which is being pressed should be kept securely in position while the table is rising to the desired height, after which the covering is adjusted and stitched preparatory to placing on the binding hoops or ropes When the bale is finished, the exhaust valve L is opened, and the weight of the bale, together with the bottom plate or table and the ram, expels the water through the 2in. bore exhaust pipe J. A turnkey is provided by means of which valves K and L may be opened or closed at will by one of the attendants. Assuming that a bale has just been packed, we shall endeavour to give a description of the various operations which obtain for each bale. To begin with, preparations must be made for the removal of the bale already in the press. It is evident that the table will now be in the highest position necessary for that particular bale. It is therefore essential to lower it to about the level indicated in Figs. 88 and 89, when valve L is closed, so that the packed bale may be rolled out on to the floor. Immediately the bale is removed, valve L is again opened to the exhaust, and the table is now allowed to fall into the most satisfactory position—perhaps to the lowest position, shown in Fig. 90—ready for the material for the next bale. In Fig. 90 it will be seen that the vertical bars M, which are used for keeping the material in position, are in their highest positions, with the balance weights N resting on the top of the upper plate. By means of a small hook which is inserted successively into each bar, the bars are pulled down until their lower ends pass through slots O in table C, as shown in Figs. 88 and 89. They are then capable of being moved towards or from the centre of the table, within certain limits, and kept in their position by means of T-shaped keys, and a "cutter" inserted in the slots O according to the desired width of the bale. The bars are moved in or out in the top plate by means of cams (one for each bar) situated on shaft P, through the medium of the hand-wheel Q on the shaft R¹, worms R, and segment wheels S. A jute wrapper of sufficient dimensions is now laid on the table, and the required quantity of goods placed thereon, the sides of the pieces generally being placed against the bars M; then a top wrapper is added, usually at right angles to the bottom one. Valve K is then opened to the pressure from the pumps; the table and contents begin to rise, and pressure is applied immediately the goods come into contact with the top plate. The bars M keep the material from falling over, or from being squeezed out at the side during the time that pressure is being applied, and the table is rising. As soon as the required pressure per square inch is obtained, the pumps are stopped, and the valves K and L are closed; then bars M are released in the top plate and withdrawn from the slots O in the table, and raised to their highest position as indicated in Fig 90. The table, however, is kept up until the bale is packed. When the vertical bars have been raised clear of the bale, the jute wrappers are arranged to cover the material completely, and are stitched up at the four sides so as to form a perfect covering. All is then ready for binding the bales either with ropes or with hoops. Ropes are often used for light material, and for light bales packed under a low pressure; but for light and heavy bales packed under high pressure, hoops are more generally used. Slots are provided in both the top plate and the table (the slots in the latter being marked T in Fig. 93) to facilitate the entering of the ropes or hoops under and over the bale. If hoops are used, they are cut according to the girth of the packed bale.

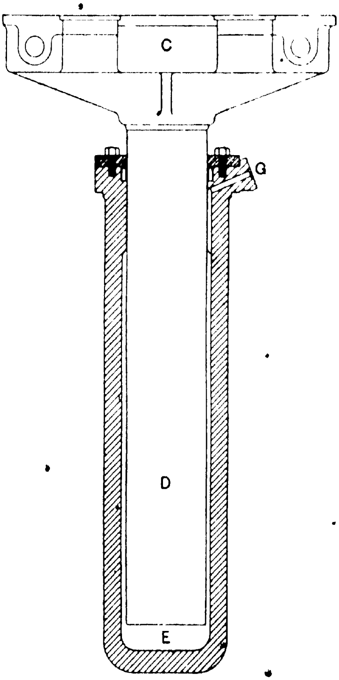


Fig. 94

Enlarged views of the steel cylinder, plunger, and table, and also the plan and elevation of a similar table, are shown in Figs. 94, 95, and 96; in all cases the lettering agrees with that in the complete views. The essential apparatus for rope binding or roping is

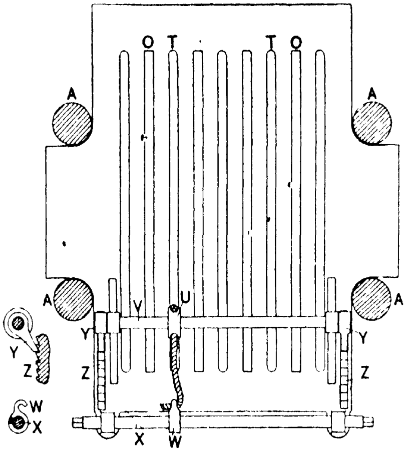


Fig. 95.

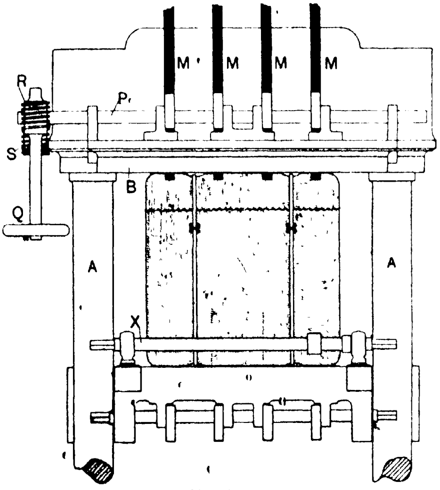


Fig. 96.

illustrated in Figs. 95 and 96. The rope is shown partly encircling the grooved pulley U on the rod V, and then caught by the hook W, which slides along the shaft X to any desired position A long groove in the shaft X and a projecting feather in the hook W permit of this movement, and also allows the hook to be carried round by the shaft. The rope is passed round the bale, the strands unwound for about 12 in., and tied into what is termed a "rose" or "crown" knot. This end is then cast in a slip knot around the main part of the rope, and the latter looped round the hook W. The shaft X is then rotated by means of a handle or box key, when the hook W carries the rope around the shaft and tightens up the part which is encircling the bale The bar V and guide pulley U may be moved into different positions, and kept securely held in any of them, according to the width of the bale, by means of pawls Y and racks Z. The rope is then cut, the strands untwisted close up to the first knot, and a further "crown" knot formed upon the end to prevent it from slipping through the first knot -the end is thus securely fastened. This process is used for light bales, but for most purposes, and invariably for the export trade, the general method of fastening the bale is by means of the parts illustrated in Fig. 97, where A is a looped end of the hoop iron , B is the buckle ; and C the pin. Both ends of the hoop A are bent, but one end only is shown in the figure. When the table has been raised sufficiently high, and the necessary pressure obtained, the pumps are stopped and the valve K is closed. Then one end of the hoop is passed under the bale along one of the slots T , brought over the top of the bale along a similar slot ; the bent end passed through the opening of the buckle, and a pin inserted into the loop or bend. With the aid of a short stiff lever the other looped end of the hoop is drawn forward until the loop may be inserted into the hole of the buckle, and another pin inserted. When both pins are fixed, the connection between the pins, buckle, and the two bent ends of the hoop is similar in end elevation to the middle illustration of Fig. 97, while the appearance in the front is shown by the illustration on the right. As soon as the pins have been placed in position, the valve of the exhaust pipe is opened and the table begins to fall, as already mentioned. The bale, being now free from pressure, expands slightly, and thus causes the two ends of the hoop A to draw the pins C firmly against the buckle B, and in this manner provide an efficient grip. If there is any danger of the wrapping being damaged by the bent portion of the hoop, and by the buckle all these parts are wrapped by a small piece of jute cloth. The general appearance of the bale when all is complete is illustrated in Fig 96, which shows the bale, encircled with two hoops, between the table and the top plate.

For very large and heavily pressed bales it is often found necessary or advisable to introduce three such hoops as those shown in Figs. 96 and 97, and sometimes to use a broader and heavier type of hoop iron.

As already mentioned, the approximate girth of the compressed bale is first roughly measured or estimated, and then the required number of hoops of the correct length is cut by a simple apparatus similar to that illustrated in elevation and plan in Figs. 98 and 99. This instrument is termed a hoop cutter, and its construction needs little explanation. The essential parts are the fixed and moving knives A and B, and their supports C and D. The knives, acting as a pair of strong shears, sever the hoop E at the desired point. The moving arm D is fulcrumed at F, and is controlled by the hand-lever G through the links H. The lever G is fulcrumed at J at the end of the suitably shaped support K. The downward movement of the handle G will evidently enable the knife B to cut the hoop iron E into suitable lengths ready to be bent at the ends to the form illustrated in Fig. 97, or to be punched with holes as the practice of the particular place demands.

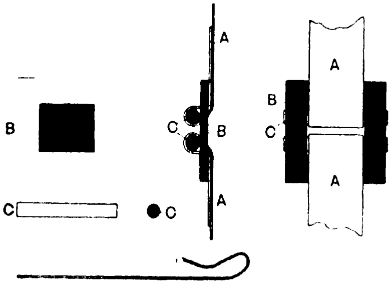
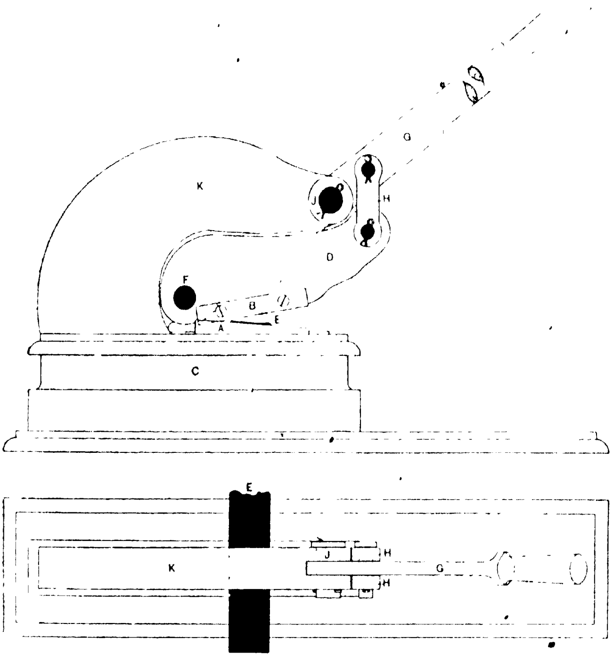


Fig 97

When hoops were first introduced for binding press packed bales, two circular holes were stamped or punched into each end of the hoop as shown at L (Fig. 100). The bands were then passed round the bale, and the ends arranged to overlap so that the holes in one end of each hoop coincided with the holes in the other end. Two rivets were then inserted into the holes of the overlapping parts, and the whole riveted together. This was a tedious process, besides being productive of a somewhat insecure and dangerous joint; but it is still practised in some districts.



Figs 98 and 99.

An improved method of fastening consisted of first punching oblong holes or slots, similar to those illustrated in the ends of the two hoops M. This was done by a simple arrangement of levers like a pair of huge nut-crackers; one arm, however, being fixed to a suitable block, while the other was forced downwards to punch the hole. Suitably shaped dies were fixed in the two arms near the common fulcrum, the hoop was inserted between the dies, and the holes punched out by forcing the moving arm downwards. The hoop was then passed round the bale so that the punched ends overlapped with the holes again coincident. Small locking studs N were then inserted with their longer sides parallel to the length of the hoop as shown in the extreme left hand hole in M. The studs, after being thus entered, were turned one quarter round as at P to prevent them from slipping out. The completed hoop then presented an appearance similar to that illustrated at O. As soon as the pressure of the press was removed, the bale expanded, drew the ends of the hoop in opposite directions, diminished the apparent size of the hole, and thus locked the whole securely together. Q and R are plans of the studs, while N and P show respectively the position when entering and the position when locked.

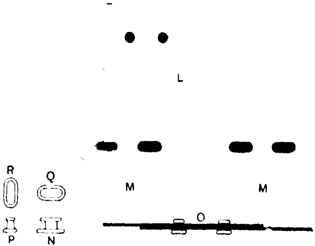


Fig 100

The modern method of preparing the ends of the hoops for joining up is, however, a great advance upon either of the two systems just described. Both of these clearly weaken the hoop at the punched parts, and throw practically all the stress upon the rivets or studs. By avoiding the operation of punching holes, a narrower thinner, and lighter hoop may be used for any particular kind of bale.

Figs. 101 to 104 inclusive illustrate a type of hoop bender in general use. Figs. 101 and 102 show the positions of the parts when the hoop end is bent; Fig. 103 shows the positions before any bending takes place; while Fig 104 indicates the positions of the chief parts of the machine when the bent hoop has just been removed. In Figs. 102 and 103 the whole of the framework, as well as the handle, is shown in dotted lines. The handle A must be in the position indicated in Fig. 103 at the beginning of the operation. Thus, with the handle A turned to this position, the hoop B is placed in the guide C, under the lock-pin D, over bending bar E,

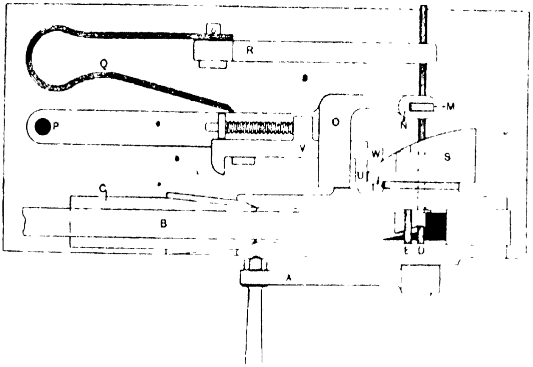


Fig 101

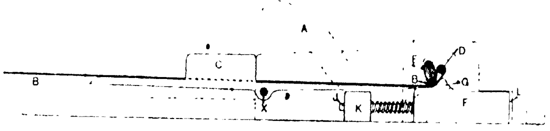


Fig 102

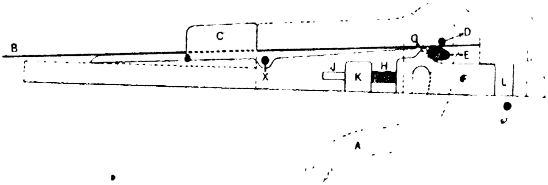


Fig 103

and pushed to the extreme right until it abuts against the framework as shown by the heavy black line. The bending bar E forms part of the boss of the handle A, and, consequently, rotates with it. It is shown in Fig. 103 in its lowest position, and holding sliding block F to the left by means of pressure on the right-hand slope of the vertical projection G. The spring H on the pin J is therefore now compressed between the fixed support K and the sliding piece F, and is ready to move the latter to the right immediately the bending bar E begins to withdraw its pressure. As the handle A is being turned counter-clockwise, the bending bar E and the sliding piece F move in unison until the latter reaches the position shown in Fig. 102—that is, when the highest point G of the sliding piece F is practically under the lock-pin D,—a position which is determined by the extent of the gap L. Any further counter-clockwise movement of the handle A, which is possible, causes the bending bar E to carry the right-hand end of the hoop B round the lock-pin D, and to impart a suitable bend to the hoop B for the purposes already described (*see* Fig. 97). Both parts of the hoop B are pressed together between the bending bar E and the left-hand slope of G, as shown in Fig. 102.

When the operation has been so far completed, the bent portion of the hoop is held fast by the parts D and E; to effect a rapid and easy removal of the hoop B it is essential, not only to rotate the handle A clockwise until the bending bar E appears to the right of the pin D, but also to withdraw the latter bodily from its present position. It will be seen from Fig. 101 that the lock-pin D extends the full width of the machine, and that at a certain point it carries a small collar M which is controlled by the forked arms N of the lever O fulcrumed at P. In Fig. 101 this lever O is shown in contact with the side of the hoop guide, being maintained in this position by the pressure of the laminated springs Q (a strong spiral spring is often used between the lever O and the fixture R to answer the same purpose); and at the same time the peculiarly shaped cam S has its narrowest part T in contact with the part U of the sliding piece V mounted on the lever O, while the part W of the sliding piece V is by spring agency pressed against the obliquely curved face of the cam S. The latter is rotated with the boss upon which the handle A is fixed. If, therefore, the handle A be turned clockwise through 180°, the bending bar E will be placed to the right of the pin D; but during this rotation of 180° the cam S will have assumed the position illustrated in Fig. 104, and in doing this, its obliquely curved face, acting on the part W of the sliding piece

V, will have gradually pushed the lever O backwards. By this means the fork N will, through the collar M, withdraw the lock-pin D to the position shown, when the bent hoop may be easily removed from the machine. There are thus three main positions of the handle A: first, when the hoop is entered as in Fig. 103, second, when the hoop is bent as in Figs. 101 and 102; and third, when the hoop is removed. This last position of the handle A is diametrically opposite to that which it occupies in Fig 102, and, although not shown, will be readily imagined by anyone interested. Finally, the hoop guide C may turn slightly upon the centre X, Figs. 102 and 103, so that its extreme right-hand end may drop to the level of the sliding block F when the bending bar E is exerting its downward pressure on the hoop B as illustrated in Fig. 102.

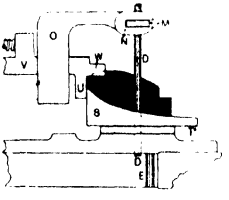


Fig 101

Hydraulic Pumps.—In order to apply the heavy pressures required for the hydraulic presses in general use for packing purposes, hydraulic pumps of heavy and substantial construction are essential Pumps for this purpose are usually of the plunger type, arranged either vertically or horizontally, the former being the more common arrangement. As a rule they are driven either by belt or by ropes, but within the last few years many pumps have received their power direct from a motor. In some cases double-acting, steam-driven, horizontal piston pumps are used, but the vertical plunger type is almost invariably installed at the present time in sets of 3, 4, 6, or 8 barrels, according to the supply and the maximum pressure desired. If the pumps consist of three barrels, the different cranks, by which the plungers are actuated, are set 120° apart upon the crankshaft in order that the delivery of water to the presses may be practically continuous; if four barrels are used the cranks and plungers are in pairs, the cranks of each pair being 180° removed, and the four cranks thus set 90° apart. Six barrels are arranged in three pairs, 120° apart, each pair being again 180° removed; while eight barrels are arranged in four pairs 90° apart, or a crank for every 45° of the revolution of the crankshaft.

Figs. 105 to 108 show various views of a modern eight-barrel

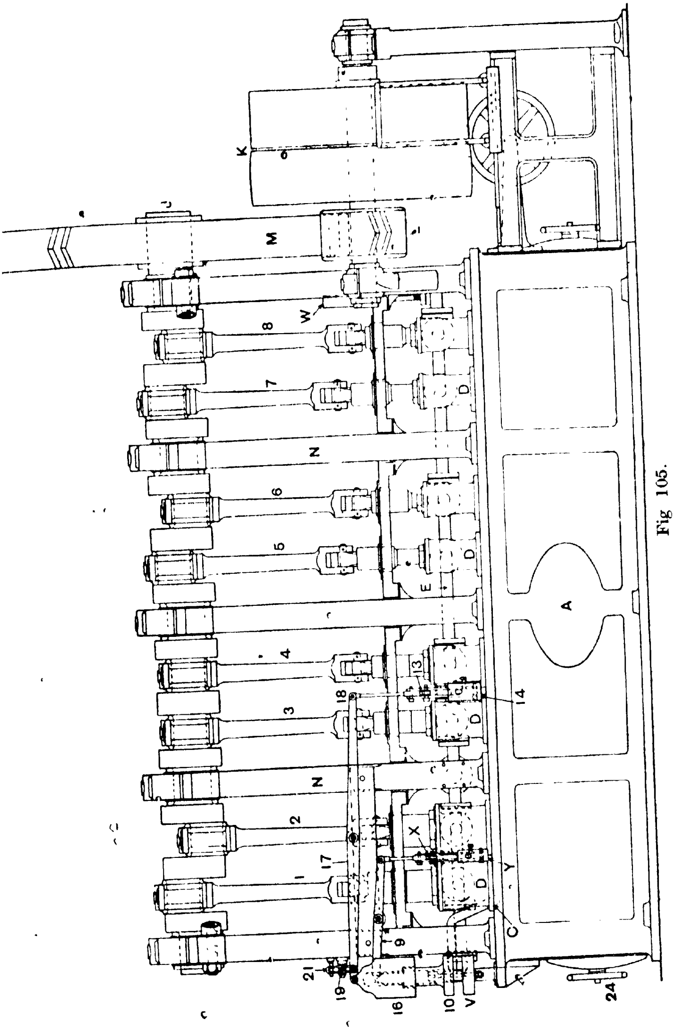


Fig 105.

installation of pumps. The pumps are of the vertical plunger type, and arranged to give a maximum pressure of three tons per square inch. Figs. 105 and 106 indicate the general arrangement of the eight plungers, the eight connecting arms for the plungers numbered 1 to 8 inclusive, the tank A, and the method of driving by means of a belt. It is, of course, understood that any other type of drive, mechanical or electrical, may be fitted to the pumps. In Fig. 106 the crankshaft is omitted, as shown by the broken ends near the bearings, in order to show up more clearly the other parts of the pumps; and for similar reasons a stay rod is omitted from the upper portion of Fig. 105. Plungers 1 and 2 (Fig. 105) are 5in. in diameter; they are capable of supplying pressure up to 15cwt. per square inch, at which pressure the safety valve B would be lifted if no other arrangements were made. A little before this pressure

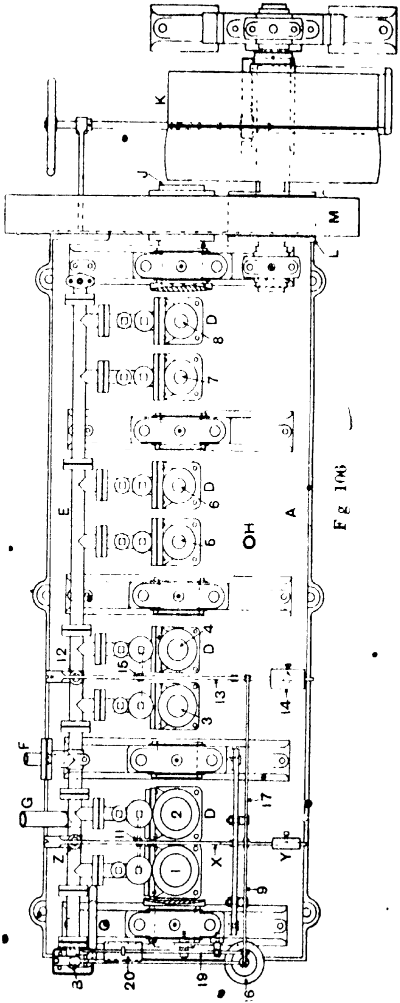


Fig 106

is reached, however, say from 12 to 14cwt., plungers 1 and 2 are automatically cut out, and plungers 3 and 4, which are capable of supplying pressure up to 30 cwt. per square inch, are brought into action. These plungers are 3½in. in diameter, and augment the pressure up to 26 or 28cwt., when they, in turn, are automatically cut out. Finally, plungers 5, 6, 7, and 8, which are 2¼in. in diameter, continue to augment the pressure up to a maximum of 60 cwts., or 3 tons per square inch. The safety valve B is then opened, and permits the excess to return to the tank through the pipe C. All plunger chambers D are necessarily connected with the tank or reservoir A, and to the main delivery pipe E, from which a delivery pipe F, 1¼in. bore, conducts the water to the packing presses. G is a return or discharge pipe, of 2 in. diameter, through which the water returns from the presses to the tank; while H is an overflow pipe with a drain connection. All the plungers have a stroke of 4in., and make about 70 strokes per minute. They are actuated by crankshaft J, the latter receiving its motion from pulleys K through spur pinion L and wheel M of 20 and 88 teeth respectively.

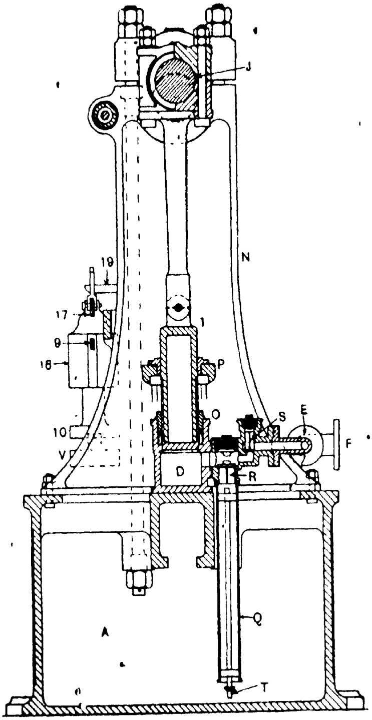


Fig 107

Before discussing the arrangement of the valves and levers employed for the cutting out of the lower pressure plungers, and the automatic increase up to the maximum pressure, it will be desirable to refer briefly to Figs. 107 and 108, which show respectively a partial sectional elevation about plunger No. 1, and an elevation of the low-pressure end of the pumps—that is, the part farthest removed from the driving end. In Fig. 107 plunger No. 1 is represented at the top of its stroke.

Tank A is a substantial casting which is rigidly fixed to the floor in order that the standards N and the other parts of the superstructure may be as free as possible from vibration. A special formation of the central portion of the upper cover of the tank is necessary, and heavy long bolts are provided (only one is shown in the figure) so that the very considerable upward thrust of the crank J may be successfully resisted. Stuffing-boxes for the proper packing of the plunger, and bushes for its guidance, are provided at O and P respectively. Q is the suction pipe, reaching nearly to the base of the tank; R is the inlet valve and S the delivery valve; and E and F are the delivery pipes. The rod T passes up the centre of the suction tube Q, and is so controlled by a valve lever above, that, when the above-mentioned pressure of 12 to 14 cwt. is reached, it is raised into contact with the valve R, and lifts the latter and keeps it raised so long as the pressure exceeds the above-mentioned limit. Under such conditions the water is simply withdrawn by the corresponding plunger, and forced back again into the tank, but not through the delivery pipe; in this way plungers 1 and 2, and afterwards 3 and 4, are cut out from the service when their maximum pressures have been reached, or rather when their cut-out pressures are reached. In order to follow how this is accomplished reference must be made to all four figures. From Fig. 108 it will be seen that the safety valve B is under the control of a simple lever U and weight V. The pressure gauge W is in line with the valve B, but it is situated at the other extreme end of the delivery pipe E, Fig. 105. The weight V is alone sufficient for the pressure of 15cwt. per sq. in.—the absolute maximum of plungers 1 and 2. When the working maximum is reached, however, the lever U must be further loaded to resist the higher pressures, and this is done in the following manner: A safety valve lever X is situated midway between these plungers (Figs. 105, 106 and 107), and is weighted at Y through a link and lever connection to give the necessary pressure to the valve Z. The lever X is also connected

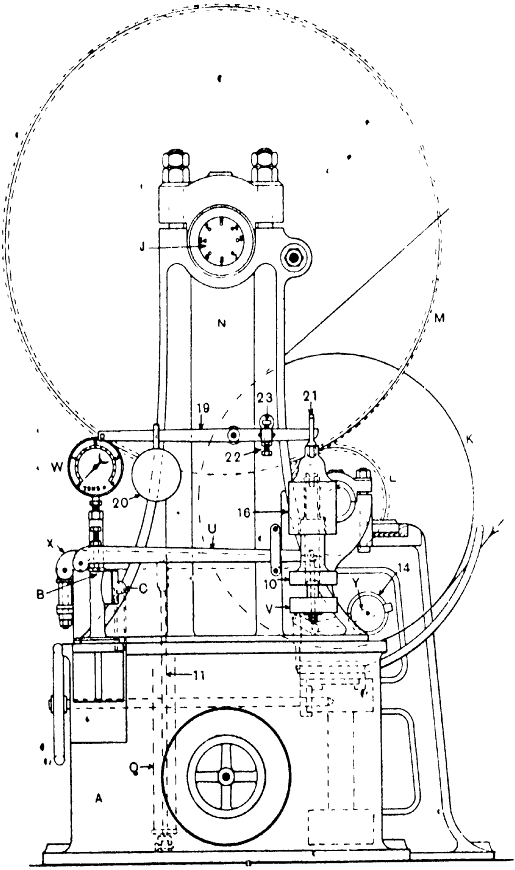


Fig. 108

above by its free or outer end to an equal armed lever 9 (Figs. 105 and 106), which carries at its free end a heavy weight 10; this weight occupies a position immediately above, and encircles a projecting portion of the safety valve weight V. As the pressure reaches the predetermined limit, the valve Z raises the lever X and the weight Y until the weight 10 falls sufficiently to rest upon the weight V, and so increases the load upon the safety valve B for higher pressures. At the same time the connecting rod 11 (Figs. 106 and 108), raises both valve rods T (Fig. 107), and places both inlet valves R temporarily out of action as far as plungers 1 and 2 are concerned. In a similar manner the plungers 3 and 4 are placed out of action temporarily through the valve 12, lever 13, weight 14, and connecting rod 15, and the pressure obtained by the weight 16 is therefore added to that of the weights V and 10 and to the safety valve B through the lever 17 and link 18.

In order that the maximum pressure upon the safety valve B may be accurately adjusted, or, in order that the safety valve B may act a little before the maximum pressure of 60cwt. is reached, a counterpoise lever and weight, 19 and 20, are provided, which come into action immediately the weight 16 falls sufficiently to bring the slotted link 21 into contact with the end of the lever 19. After the set-screw 22 is clear of the upward stop 23, adjustment of the weight 20 may be made to the maximum pressure desired, as indicated by the gauge W. In many cases pumps are worked without a pressure gauge, the belt itself acting as a pretty safe regulator by slipping before any dangerous pressure can be reached. Of course, such a method of working would be quite unsafe if the belt were able to transmit sufficient power to exceed the 60cwt. per sq. in. without slipping. Manholes 24, Fig. 105, are provided at each end of the tank for easy entrance for fitting up and for cleaning purposes.

Messrs Charles Parker, Sons & Co., Dundee, introduce a rather unique system of mechanism into their hydraulic pumps, which are illustrated in Figs. 109 to 111. Fig. 109 is a complete view of the pumps; Fig. 110 is an elevation of one plunger with the end frame and gearing; while Fig. 111 is the right-hand elevation of Fig. 109. It is interesting to note that this firm supplied the first set of pumps for the jute industry in Calcutta about the year 1870, and that these pumps are still in use. The pumps may be driven by a motor if desired, but in the illustration they are shown provided with driving pulleys A on shaft B. These pulleys are 38in. in diameter and 8in. broad, and are usually run at 240 revolutions per minute. On the other end of shaft B is a pinion C which gears with the large wheel D on the crank shaft E. Wheels C and D are illustrated with straight teeth, and although some firms still adopt this type, it is more usual to supply double helical wheels with these pumps.

The machines are made with any practicable number of pumps, the one illustrated in Fig. 109 showing eight, and numbered 1, 2, 3, 4,

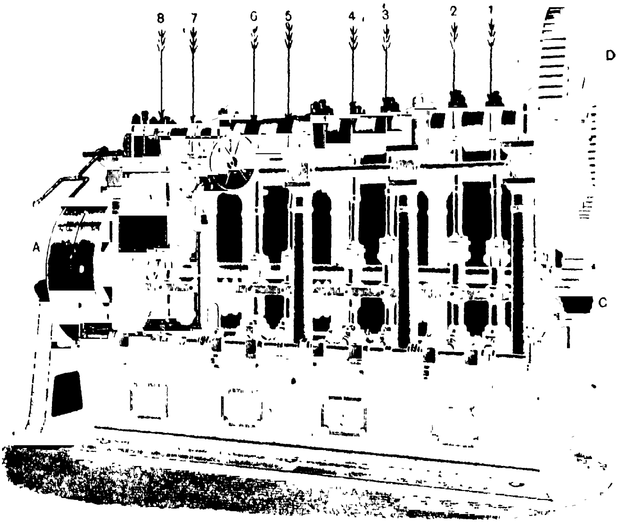


Fig. 109

5, 6, 7, 8. The plunger rods are placed on the crank shaft E in the order shown on the circle in the upper part of Fig. 110. A reference to the pumps illustrated in Fig. 106 will show that similarly-sized pumps are side by side, but in the present example similarly-sized pumps are four places removed; again, the cranks are diametrically opposite to each other on the shaft E, thus minimising the torsional stress on the slings.

A system of cutting out certain pumps at definite pressures also obtains in the present example. The safety valve, which opens should a pressure of 50cwt. per square inch be reached, is at the driving pulley side of the pumps, but it is very similar to the parts illustrated in Fig. 111, which are for cutting out the pumps in pairs and successively at 5, 10 and 20cwt. per square inch. The following table gives the particulars with regard to this work :

| Number of Pumps. | Size of Pumps. | Disengaging Pressure | Maximum or Relieving Pressure |
|---|---|---|---|
| 1 and 5 | 3½in. | 5cwt per sq in | .. .. |
| 2 " 6 | 2¾ " | 10 " " | .. .. |
| 3 " 7 | 2¼ " | 20 " " | .. .. |
| 4 " 8 | 1¾ " | .. .. | 50cwt. per sq. in. |

It will thus be seen that the cutting off is performed at three stages as compared with two in the pumps illustrated in Figs 105 to 108, but a similar arrangement to the latter may be introduced if desired.

The actual working of the pumps is practically the same in both cases, so it is only necessary to describe the mechanism for cutting out the various pairs at the proper pressures A pressure gauge F, with suitable fittings and connections, is supplied, but in many cases this indicator is not consulted.

When the pumps are in work, the valve Z in valve seat G is kept closed while the pressure is within the prescribed limits by the main lever H, fulcrumed at J in bracket K, and the weights L, M on rod N. The movements of the lever H are restricted by the slot in the bracket O, the latter being so adjusted that the lever H touches the top of the slot before the flanged plate P reaches the bracket Q, otherwise it is clear that the bracket would suffer ; while the lower part of the lever H, when in its lowest position, is nearly half an inch from the bottom of the slot.

About centrally situated on the main lever H is a stud R upon which is supported a link S. The lower end of the latter is attached to the lever T, fulcrumed on a rod U which extends to the other end of the frame. Two sets of levers V, three in each set, are fixed to the same rod U, and near, respectively, pumps 1, 2, 3 and 5, 6, 7 : numbers 4 and 8 do not require these parts. From each lever V depends a rod W which passes through a hole in its corresponding trigger lever X, fulcrumed on a pin Y. Three of these trigger levers X belonging to pumps 1, 2, 3 are shown in profile in Fig. 111 in stipple, line, and solid black respectively; in the pumps, however, the brackets which support the pins Y are angled according to requirements. The other set of three trigger rods for pumps 5, 6, 7 are identical with those shown.

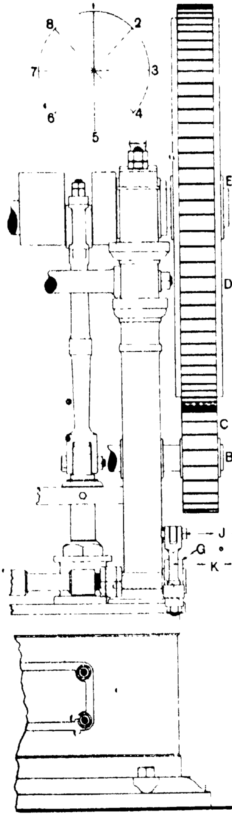


Fig. 110.

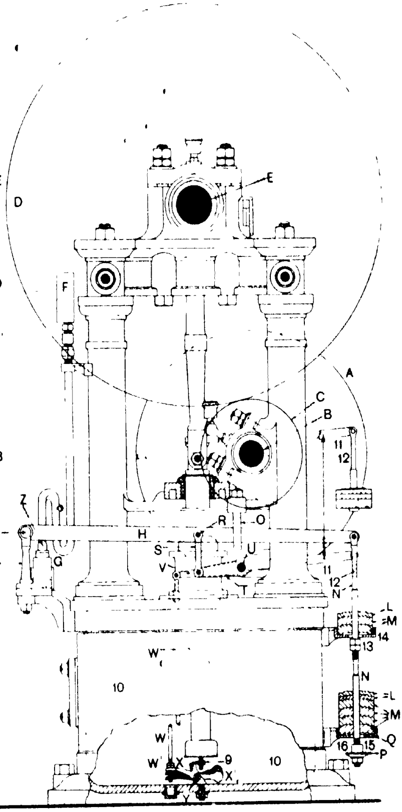


Fig. 111.

Each trigger lever X is weighted at its end $X^1$ and has, therefore, a tendency to rotate clockwise, as viewed in Fig. 111. Nuts $W^1$ on rod W, however, prevent this clockwise movement of lever X until such time as the rod W is raised through the action of valve Z in the valve seat G. The suction rod, with its nuts 9, rises every stroke to admit water from the cistern 10, and returns again to its lowest position until the pressure reaches 5cwt. per sq. in. At this pressure the lever H, link S, levers T and V, rod W, and nuts $W^1$ are also raised, and the latter thus allows the weighted end $X^1$ to rotate the lever X and so place the end of its vertical arm under the nut 9. This movement simultaneously places the vertical arm of the next or lined lever X in the position at present occupied in Fig. 111 by the stippled vertical arm, and also brings the vertical arm of the black lever to the position at present occupied by the lined lever. So long as the pressure keeps between 5 and 10cwt. per sq. in., the parts are kept in these positions, and hence the two 3½ in. pumps, Nos. 1 and 5, are cut out because the vertical arm of the stippled lever X prevents the suction rod and nuts 9 from falling.

When the pressure reaches 10cwt. per sq. in., the second or lined lever X is liberated by the upward movement of its own rod W and nuts $W^1$, and hence the upper end of the vertical arm of the lined trigger lever X slips under the nuts 9 of the suction rods of the 2¾in. pumps, Nos. 2 and 6, and these are therefore cut out. Similarly, at 20cwt. per sq. in. the vertical arm of the third or black trigger lever X slips under its nut and cuts out the 2¼in. pumps, Nos. 3 and 7. Finally, when the pressure reaches 50cwt. per sq. in. the safety valve near the driving pulleys in Fig. 109 is opened and the water flows back into the cistern 10.

A counterbalance lever 11 is also fulcrumed at U, and carries a rod 12 with similar weights to L and M. The force for the initial pressure is obtained by the weights of the lever H and rod N minus the force due to the counterbalance lever 11 and its weights. When the lever H is raised at a pressure of 5cwt. per sq. in. the first cut-out takes place. When the pressure reaches 10cwt. per sq. in. the the lever H rises still further until the nuts 13 on rod N pass through the hole in bracket 14, and thus lift the two large and one small weights from their cup base to float with the rod N. In a similar manner, the rod N is still further raised until the boss 15 passes through the hole in bracket 16 to carry the four large and two small weights for the higher pressures.

# CHAPTER X

## BAG OR SACK-CUTTING FRAMES AND MACHINES

BAG OR SACK MAKING.—Besides the large quantity of jute piece-goods which is used in both the natural and dyed states, there is an enormous quantity of all the typical plain and twilled jute fabrics made up into sacks and bags of various kinds and sizes. These vary in an almost infinite variety from the small bags used for ore and other heavy substances to large wool packs. A moderate quantity of the smaller sizes of these bags is almost completely formed in the loom, as explained and illustrated in "Textile Design: Pure and Applied," pp. 329 to 336, but by far the larger proportion is made by cutting up the woven pieces into definite lengths of cloth according to the size of the bag required, and then completing its form by sewing the bottom and side, or the sides only, by one or other of the various sack-sewing machines.

The bags made by circular weaving may have something to commend them, especially the linen and cotton ones which are used for pillows, cash bags, small bags for flour, etc., but, in addition to the complications which arise in the weaving of these articles, there is the increased difficulty of finishing them—a difficulty which does not arise in the finishing of piece-goods intended to be used for the production of similar articles.

After finishing, the first operation in the making of a bag from piece-goods is clearly that of cutting the cloth into the proper lengths—an operation which may be done either by hand, or by machine. Power sack-cutting machines cut off the desired lengths of cloth quickly, but they treat only one piece at a time; whereas in the hand-cutting machine any number of pieces up to nine or even more may be cut at one stroke. One method of measuring off and cutting sack lengths has already been mentioned incidentally in connection with the description of lapping machines, but the general method of cutting by hand is that referred to above, and is performed on an apparatus similar to that illustrated in Figs. 112, 113 and 114. Figs. 112 and 113 respectively are complete views of the apparatus in elevation and plan, while Fig 114 is an enlarged view of the end of the table and the chief parts for cutting the several layers of cloth. The finished pieces are usually brought in a loosely folded condition and dropped on the floor immediately under the guide rollers A. The end of each piece in succession is taken over its own guide roller A, under the pressing roller C of table B, under the knife support and guide D, and laid on the table. In Fig. 112 six pieces are shown in position, and the arrows immediately above the guide rollers A show the direction in which the cloth is taken.

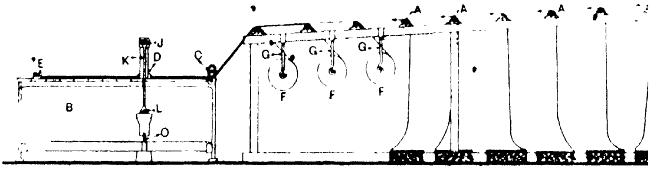


Fig 112

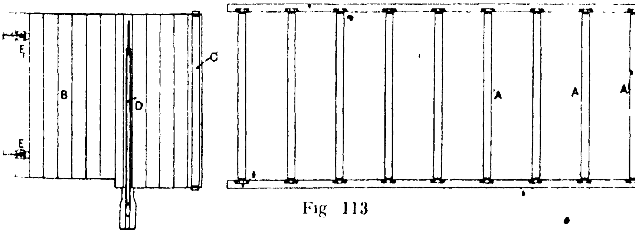


Fig 113

By the time the ends reach the pressing roller C there will clearly be six thicknesses of cloth to pass between the table and the knife guide D. The ends of the several pieces are now brought into line with each other, and ultimately into close contact with the adjustable stop pieces E. One or two boards of the table, near the knife support D, may also be adjusted, so that with this double adjustment provision is made for practically all lengths of cloths. The adjustment for small variations in length is usually made by the parts E which provide the simplest and most convenient means. In some cases paper-lined pieces require to be cut ; when this is the case the combined materials are made into rolls F, and are supported from the framework by the suspending irons G. These rolls are very heavy, and seldom more than three rolls are treated at a time. Again, sacking and hessian cloths are sometimes tarred together for making strong sugar bags ; the combined fabrics are then usually formed into rolls and treated as shown at F. The degree of stretching in the two combined pieces is more uniform than that of cloth and paper, and the latter, when joined to cloth, is inclined to crack and split. In order to minimise the danger of splitting special crimpled paper is now used. This yields even more than the cloth, and hence broken paper is rarely met with when this paper is used. Occasionally three pieces are tarred together for special purposes. In every case, however, the number of pieces to be cut is passed under roller C as stated, and when the proper distance between D and E, Fig. 112, is obtained, the pieces are ready to be cut.

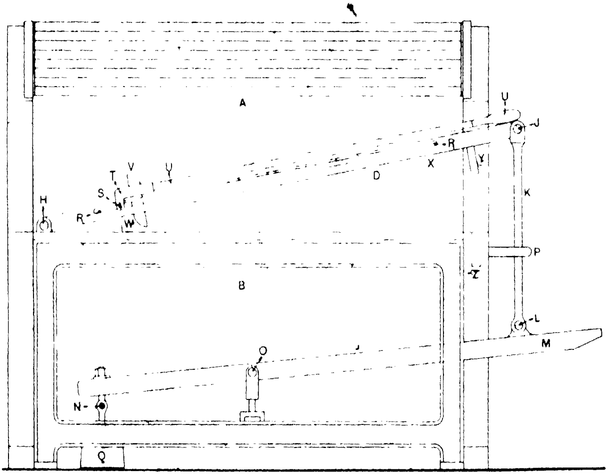


Fig 114

The cutting apparatus is more clearly illustrated in Fig. 114, although it is well to consider all the three figures when following the description. The knife support D is fulcrumed at H, while its opposite end J is attached to rod K. This rod is in turn connected flexibly at L to the lever M. The latter oscillates freely upon pin O, and is guided in its vertical movement by staple P, which encircles rod K. The weight Q provides a counterpoise sufficient to keep all parts in the position shown during the time that the ends of the pieces are being drawn forward, and to return the knife guide D to its present position after each cutting operation. A long slot R is formed in the side of the support D to provide a free movement for the fulcrum pin S of the knife holder T. The knife holder is attached to the long handle U, while the knife V is fixed adjustably in the holder T, and passes through a vertical slot in the carrier D until the cutting part W projects below. As previously stated, the group of pieces lies on the top of the table but under part D. Immediately under D a long slot is formed in the table in the same vertical plane as the slot in D, this slot is for the passage of the lower end W of the knife V W.

Two men are required at this frame, one at each side. They first draw the ends of the pieces forward until they touch the stop pieces E; then the chief operator or cutter draws handle U forward until knife V W is near the pin Y; he then presses down treadle M, by means of an auxiliary and more convenient treadle placed at right angles to M, until part D reaches the cloth. The support D is meantime guided to its proper position by the pin Y entering the corresponding slot Z. The downward movement of treadle M causes the pieces to be gripped firmly between the table and the support D, and when they are thus securely held the cutter pushes handle U forward, when the cutting end W of knife V, which is, of course, at this moment in the slot and near Y, severs all the cloths at the same time. The operations of drawing forward new lengths, depressing treadle, M, and cutting the cloths, are quickly performed, and the resulting lengths for the bags are practically uniform.

The frames and apparatus illustrated in Figs. 112, 113 and 114 are in general use for ordinary sack cutting, and very successful and accurate work is done by means of them for most of the ordinary lengths of bags. There are, however, some exceptionally long lengths or cuts required for certain classes of bags, and for this type the work is done more easily, and perhaps more accurately, on specially long tables. Such a table, with a newer and somewhat different equipment, is illustrated in Figs. 115, 116, and 117. This apparatus was originally provided with change pinions in addition to drawing rollers for obtaining the proper length of cloth for the bag, but in the modern frame, as illustrated, these pinions have been replaced by an index finger and a marking rod. These are shown respectively at A and B—an enlarged view of the pencil, pencil support, and grooved board being illustrated in the detached view in the upper part of Fig. 116. The corresponding parts in all these figures are lettered alike.

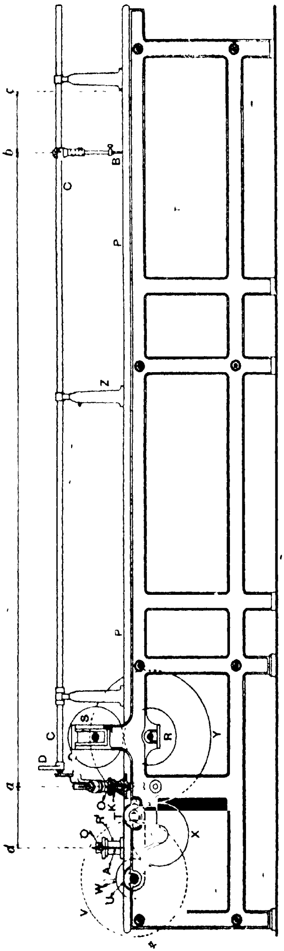


Fig 115

The pencil support is fixed on the long rod C, which is attached, as shown, by means of a crank D and connecting rod E to arm F. This arm is secured to the curved lever G fulcrumed at H, which is also the fulcrum of the knife support J; as a matter of fact, the parts G and H are in one piece, and when the knife support is out of action its forward end K is kept elevated by the counterpoise weight L. On the other hand, when the various layers of cloth are gripped between the table P and the knife support J K, the latter is held down firmly by means of the hook M, which engages with the top of the knife support. The actual operation of cutting is identical with that explained in connection with Fig. 114—*i.e.* the handle N is drawn out to the right, then depressed so that the knife O may be inserted into the slot of the knife support and in front of the cloth, and then pushed forward until the knife has cut the full width of the cloth. When the knife support J and the lever or arm G are in the position indicated in Fig. 116, the pencil B will be to the left of the vertical position, whereas when the support J is lifted, the pencil B will be on the right of the vertical. Now it is evident that if a piece of cloth be on the table P and under the marking pencil, the latter will mark the cloth as it is passing the vertical position illustrated. The mark thus made by the pencil,

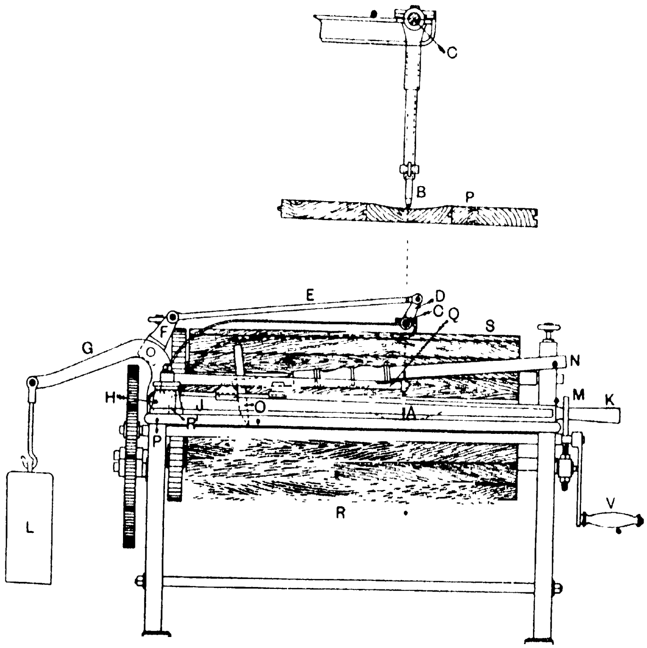


Fig 116

simultaneously with the changing of the position of the knife support, is afterwards used as a guide for the next cut. It will be observed that the pencil B and the index finger A are in the same straight line—a necessary condition for accurate work. The index finger is held firmly, but adjustably, at the extreme end of the rod Q, which is in turn supported on pedestal R. When the index is accurately adjusted, the rod Q is securely locked in position by a nut on the end of pedestal R.

The pieces of cloth, loosely folded or in the rolled state, are placed as usual in frames similar to those illustrated in Figs. 112 and 113, and the ends are brought along the table P, Fig. 117, and passed between the drawing and delivery rollers R and S. The former rotates in fixed supports, while the latter is supported by blocks which slide between suitable guides; the blocks, and therefore the roller S, are pressed towards the bottom roller R by means of steel springs, the strength of which may be regulated by screws as illustrated.

The operations of marking and cutting will probably be better understood by reference to Fig. 116. After the cloth has passed between the rollers R and S, the ends are further passed between the table P and the knife support K; the latter is then pressed down so that cutting may take place. From what has been said with reference to Figs. 115 and 116, it is obvious that when the knife support K is depressed to grip the cloth, the latter will be marked by the pencil some distance farther back, because of the simultaneous movements of the two parts. The handle of the knife is then pushed forward in order to cut off the frayed or uneven ends of the pieces, and thus make all straight. The knife support K is then raised, and the cloth rolled forward until the pencil mark coincides with the point of the index finger A, when another length is cut and marked. The actual length of cloth required is equal to the distance between *d* and *b*, Fig. 115, or between *a* and *c*, so that although the end of the cloth is cut immediately under *a*, it is clear that the next cutting-place will be at a point immediately under *c*. The cloth, however, is marked under *b*; but it must be remembered that when the cloth is carried forward, the marked place, now under *b*, will be brought to the index finger A immediately under *d*, and the cloth cut under *a*. The mark is always brought to the index finger, and the cutting takes place to the right of it at a distance equal to *d a* or *b c*.

After each operation of cutting, the cloth is carried forward by the rollers R and S, and by a cloth apron sheet which rotates with the rollers T and U; the roller R is positively driven by means of the handle V, Fig. 117 (the path only is shown in dotted lines in Fig. 115), and the train of wheels W, X, and Y

The table shown in Fig. 115 is approximately 15 ft. in length, but longer tables are supplied when desired. The long tables naturally occupy a large amount of floor space, but they have the advantage of being suitable for all lengths. When shorter lengths than that illustrated are required, the pencil holder B is moved along the rod C, and it may with ease be carried to the left of brackets Z when very short lengths are to be cut.

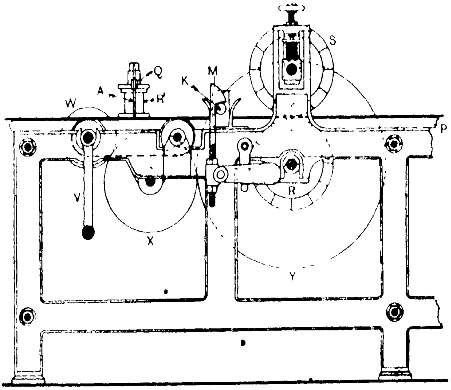


Fig 117

Although the cutting of bag lengths, like most cutting-out operations, would probably have originated in cutting single pieces or lengths of cloth, it is not surprising to find—indeed, it is almost natural to expect—that the cutting of two or more thicknesses simultaneously would quickly be attempted, and that gradually these thicknesses would be multiplied until the maximum number, consistent with accuracy and with ease of manipulation, would be ultimately obtained. This maximum number may or may not yet have been reached, but the very fact of its being possible at present to cut ten or more pieces satisfactorily at the same time, for the particular purpose of bag making, is probably the reason why the hand process of bag cutting still survives, and even predominates, at least in this country. At the same time there is a very large number of power sack-cutting machines at work, and they may be found in practically all countries where bag making is practised to any great extent.

The original power sack-cutting machines lacked that accuracy which is essential for the purpose, but the gradual evolution of the power machine has resulted in the elimination of most, it not all, of its drawbacks. To begin with, the greatest drawback was that of irregular lengths ; but now there is not much difficulty in turning out, quickly and uniformly, bag lengths of any dimension. As now made, the machine is suitable for almost all kinds of cutting.

Figs. 118 to 123 inclusive illustrate the chief or essential parts of practically all power sack-cutting machines, the machine shown being that made by Messrs Charles Parker, Sons & Co., Dundee. Fig. 118 is an elevation of the delivery side of the machine, where the cloth, or at least the severed lengths, are delivered. Fig. 119 is an elevation of the driving end of the machine , while Fig. 120 is an elevation of the opposite end. The remaining figures deal more or less with various details of the mechanism. When driven by belt, which has been the method up to the present, the machine is put in and out of action by the usual fast and loose pulleys, A and B, of 22½in. diameter, Figs. 118 and 119, and from the former of which the motion is transferred to gearing on both sides of the machine. Consider first the driving of the measuring drum or roller C. A pinion D of 49 teeth (Fig. 119) on the main shaft drives wheel E of 115 teeth ; this latter wheel is simply a carrier, and transmits the motion to the intermediate driven and driver wheels F and G. The former contains 70 teeth ; and the latter, being the change pinion, is of a variable size, and imparts the movement to wheel H of 84 teeth on the shaft of the measuring roller C, which has a circumference of 42in. The direction of motion is shown clearly by the arrows near the peripheries of the pulley and the measuring roller, while the path followed by the cloth is distinctly emphasised by the heavy line and by the various arrows.

Originally the cloth was drawn forward by means of two rollers, and the main or measuring roller was driven negatively by spikes projecting into the cloth. In other machines the measuring roller and pressing roller draw the cloth forward, while pressure is applied to the cast-iron top roller by screws and by indiarubber pads. The cloth is tensioned first by the two rails fixed in the rack-wheel J, by the joint action of which rails any required amount of tension may be applied to the cloth. The latter then passes over and under two

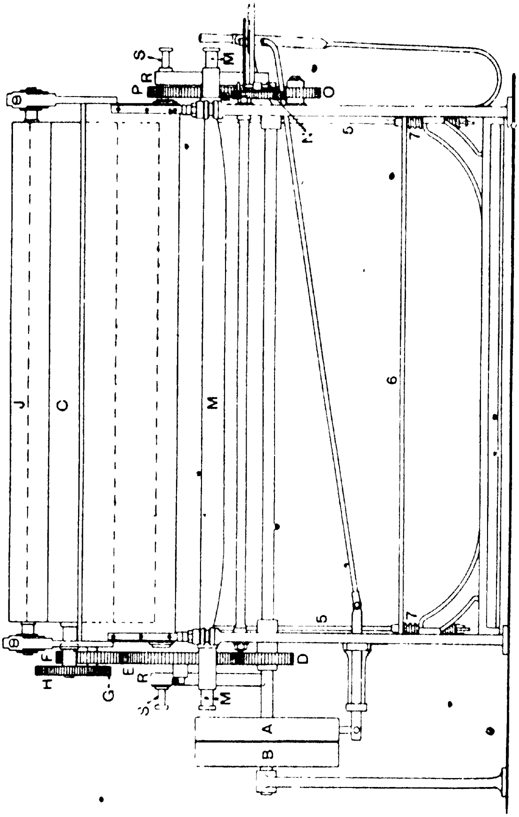


Fig. 118

guide rods, then round the measuring roller C, under pressing roller K, and is finally guided by the board L through a slot (to be explained shortly) in its descent to the floor on the side of the machine opposite to that on which it entered.

The speeds of the wheels D, E, and F are constant, but the speeds of G and H, and consequently of the measuring roller C, are altered by the size of the change-pinion F. The usual facilities for the accommodation of differently sized change-pinions are provided as shown by the slotted bracket concentric with wheel E.

A normal rate of speed for the pulley is 70revs. per min., therefore:

$$\frac{70 \times D \times G}{F \times H} = \text{the revs. per min. of roller C}$$

$$= \frac{\text{Length in inches per minute}}{\text{42in. circumference}}$$

—*i.e.*
$$\frac{70 \times 49 \times G}{70 \times 84} = \frac{l}{42\text{in.}};$$

whence
$$l = \frac{70 \times 49 \times G \times 42}{70 \times 84}$$

$$l = 24\tfrac{1}{2}\,G.$$

If, therefore, the knife M makes $24\frac{1}{2}$ strokes per minute, the number of teeth in any change-pinion G will indicate the length in inches of the cloth cut with that pinion in use.

Now let us consider the method of driving the moving knife M. The main or driving shaft passes from the pulley A to the other side of the machine, and carries at the far end a spur-wheel N, Figs. 118 and 119. This is the change-wheel for altering the number of strokes per minute of the knife M. But this change-wheel N communicates its motion, through a single or carrier wheel O of 45 teeth, to wheel P of 120 teeth on shaft Q. Consequently, the revolutions of the shaft Q, and therefore the strokes per minute of knife M, may be found as follows:—

$$\frac{\text{Revs. of pulley} \times N}{P} = \text{revs. per min. of shaft Q, and strokes per min. of knife M.}$$

If N has 42 teeth, then—

$$\frac{70 \times 42}{120} = 24\tfrac{1}{2}\text{revs. of Q, and strokes per min. of knife M.}$$

Consequently, if a wheel of 42 teeth be used at N, we see that the desired length in inches of the cloth may be obtained by introducing a change-wheel at G, the number of teeth of which is identical with the length in inches to be cut.

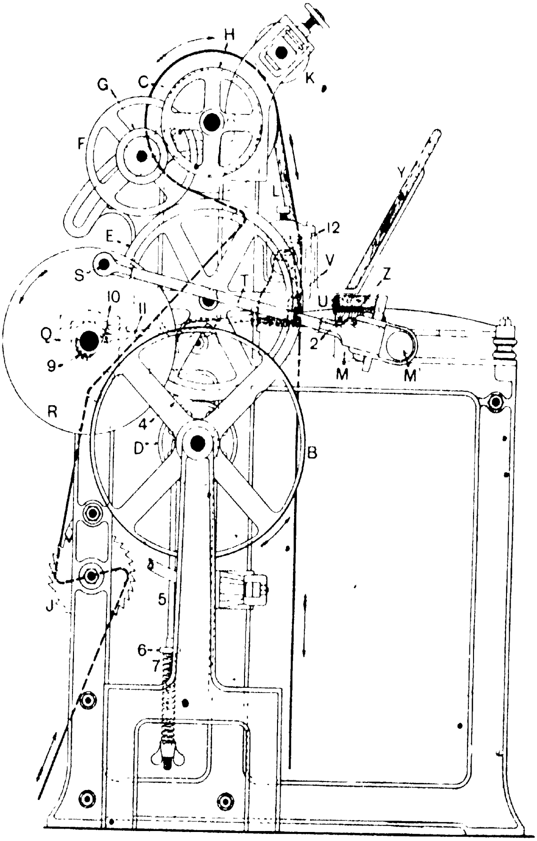


Fig 119.

When medium and long lengths have to be cut, it is usual to reduce the number of cutting strokes per minute to 16½ and 12¼ respectively, by introducing smaller wheels at N; thus—

$$\frac{70 \times 28}{120} = 16\tfrac{1}{3} \text{ strokes of M for medium lengths;}$$

$$\frac{70 \times 21}{120} = 12\tfrac{1}{4} \text{ strokes of M for long lengths.}$$

Each tooth in change-wheel G, Figs. 118 and 119, then represents not one inch of cloth, but 1½in. for medium-length bags, and 2in. for long bags. This will be evident because the delivery of cloth for any one change-wheel G will be constant, whereas the cutting strokes per minute of knife M are proportional to the size of the change-wheel N. Thus—

48 : 28 : 21, as 24½ : 16⅓ : 12¼.
∴ Pinion G for short lengths = length in inches to be cut.
,, ,, medium ,, = ,, ,, – 1½.
,, ,, long ,, = ,, ,, – 2.

These are the wheels which are generally used, and they cover a wide range; when, however, it becomes necessary to cut to ¼ or ⅛in., other wheels are naturally essential, and these are supplied when required.

On the end of shaft Q, Figs. 118 and 120, is fixed a disc R, and studs S near the peripheries of these discs enable rods T to be connected to the two ends of the moving knife M. When the stud S is approaching, and is comparatively near, the full forward position, the cloth is gripped tightly so that the cutting may be done efficiently; and while the knife M and the stud S are moving towards the back centre, the severed length of cloth drops to the floor. Figs. 119, 120, and 121 will demonstrate clearly how these operations are performed. Since the measuring roller C rotates continuously while the machine is in motion, it is evident that some means must be provided for dealing with the cloth from the time it is gripped to the time of its being released—during which limits the actual cutting takes place. We may imagine that the cloth in Fig. 119 is still descending towards the floor while the grip U, shown in solid black, is moving in unison with the knife M towards the other and almost stationary grip V. The grips close upon the cloth a little before the knife M reaches its full forward position—indeed, the cloth is securely held in the grips before the knife itself reaches the cloth (*see* Figs. 121 and 122). In the latter figure the cloth, representing a 40in. fabric, is shown by a heavy black line,

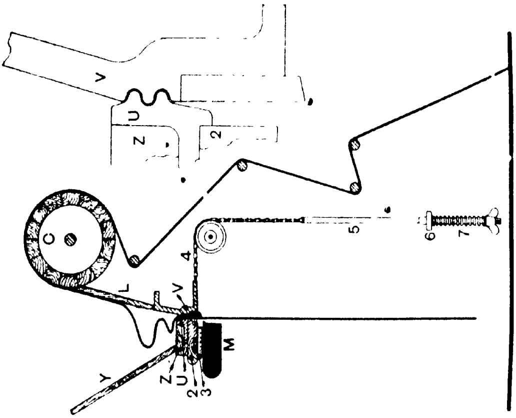


Fig 121

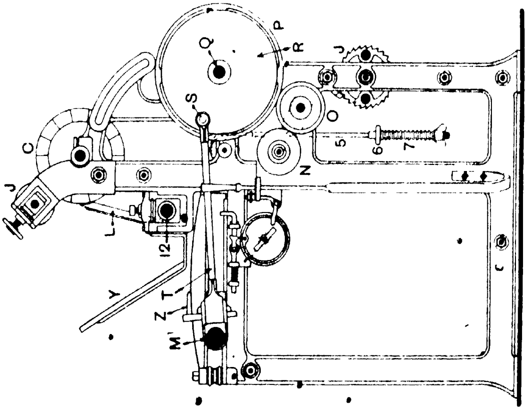


Fig 120

and the two selvages are just in contact with the actual knife-edges W and X. The formation of the moving knife-edge W shows plainly that each separate cut proceeds gradually from the two selvages towards the centre of the cloth, the latter being kept midway between the frames by disc guides on the cloth guide rails. It is obvious, however, that immediately the grips come in contact with each other (Figs. 119 and 121), the descent of the cloth below the grips will cease, although it is still being delivered at a constant rate by the measuring roller C. During this period the cloth naturally collects between the two boards L and Y, somewhat as indicated in Fig. 121, the wooden support Z of the grip V closing, for the time being, the opening between the two boards L and Y. When the blocks Z and 2, and grip U, are receding from the grip V, the lower and temporary support of the cloth is clearly withdrawn, and, as a consequence, the collected material drops through the slot, and the cloth continues to descend until the grip U again nears the full forward position.

The backward movement of parts U, Z, and 2 are positive, but their forward movement is negative. Attached to the underside of block 2 are two flat pieces of iron 3 (Figs. 121 and 122), one at each side of the machine; each piece 3 is > or < shaped so as to fit corresponding shapes on the frame as shown, and thus provide means for keeping them horizontal, and for facilitating their to-and-fro sliding movements. To each piece 3 is attached a chain 4 (Figs. 119 and 121), which passes over a pulley, and is then attached to a rod 5. A long flat bar 6 is then supported by two springs 7, one on each rod 5 at opposite sides of the machine. Immediately behind moving knife M a small flat piece of iron (8, Fig. 122) is secured to the knife, and projecting about half an inch above its upper surface. As the knife M moves backward, the projections 8 (one at each end of the knife) come in contact with the slide pieces 3; consequently, the chains 4, rods 5, bar 6, and springs 7 are drawn bodily upwards until the knife commences the return stroke. When this happens, the parts 4, 5, 6, and 7 descend in keeping with the inward motion of the knife M until the grips U and V meet, when the movement of parts 4, 5, 6, and 7 naturally ceases, but the knife M continues a little farther forward in order to complete the cutting operation. It will be understood that parts 3 and 8 (Fig. 122), are not joined, and that although part 8 takes parts 3, U, Z, and 2 (Figs. 119 and 122), positively in one direction, it has none other than a restraining influence upon them when moving in the opposite direction. In order to prevent any damage occurring to the edges of the knives when the knife M is moving from the forward position, knife V is made to oscillate slightly so that knife M may pass without touching it. When the stud S is on the front centre, a small cam 9 (Fig. 119), on shaft Q acts upon anti-friction roller 10, and therefore pushes rod 11 forward; rod 11 abuts against the lower part of V, centred at 12, and thus causes a slight movement of the whole part, thereby effecting the desired clearance between the knives on the backward stroke. The detached illustration in Fig. 121 shows the grips on a much larger scale.

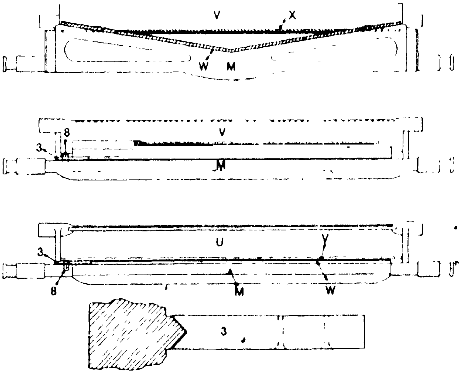


Fig. 122

Although in many cases unnecessary, it is very convenient to be able to record the number of lengths which are cut, and also to stop the machine when this number is reached. Such a motion is attached to this machine, and its action will be understood by reference to its plan and elevation in Fig. 123. It has been shown that every forward movement of knife M cuts a length of cloth, provided there is cloth there to cut, and advantage is taken of the movement of the knife, or at least the block which carries the knife, for moving the parts which record the number of lengths-cut. At a convenient point of the part M a small pin 13 is inserted which comes in contact with the upturned end of sliding rod 14 as the block M approaches the end of its forward stroke. A swinging pawl 15, fulcrumed at 16, rests by gravitation in one or other of the recesses of the teeth in wheel 17, so that when the rod 14 is pushed by pin 13 just at the end of the stroke of M, the pawl 15 moves the wheel 17 one tooth clockwise, and is forced back into the next tooth by spring 18 when pin 13 recedes. The backward movement of pawl 15 is limited to one tooth of wheel 17 by means of projecting pins 19, which are arrested by one of the rod guides 20. The rotation of wheel 17 is, therefore, quite simple, but extra parts are necessary if the machine is to be stopped when a given number of lengths have been cut.

Projecting from the face of disc 30 is a pin 21, which, in its present position, is just touching the horizontal arm of the bell-crank lever 22, fulcrumed at 23. The upper end of the vertical arm of this lever occupies a position immediately behind one end of lever 24, fulcrumed at 25 in the set-on bracket 26. The other end of lever 24 is just in touch with the set-on handle 27 (shown in section). From the position of the parts it is evident that, when wheel 17 (to which disc 30 is clamped) is moved one tooth at the next forward stroke of M, pin 21 will depress slightly the horizontal arm of lever 22, and that at the same time the vertical end of lever 22 will move lever 24 so that the forward end of the lever will press the set-on handle 27 from its recess and cause it to spring to position 28, when the belt will naturally be moved to the loose pulley B, Fig. 119. A small pin 33 limits the movement of the catch end of lever 24, and thus keeps lever 22 in a convenient position.

The wheel 17, Fig. 123, contains 103 teeth, sufficient to allow a maximum of 100 lengths of cloth to be recorded. The numbers on the wheel are arranged counter-clockwise, and the zero mark on the wheel is set to the pointer 29, whatever number of lengths is to be recorded. Disc 30 is then clamped to wheel 17 by hand-screw 31 in such a position that the mark or arrow 32 on disc 30 coincides with the number on the wheel which indicates the number of lengths to be cut. The relative positions of pin 21 and arrow 32 upon the disc are such that when the arrow 32 coincides with the pointer 29, the pin 21 will act to release the set-on handle. It therefore follows that if the arrow 32 be set opposite number 1 on wheel 17, as indicated in the drawing, only one length of cloth can be cut before automatic stoppage takes place; if arrow 32 be set opposite No. 60, then 60 lengths will be cut, and so on. The greatest number is 100; for this number the arrow would be rotated until it coincided with No. 100, and at this time the pin 21 would be immediately under the end of the horizontal arm of bell-crank lever 22, and would obviously have to travel almost a full revolution (100 teeth) before it appeared again in its present position and ready

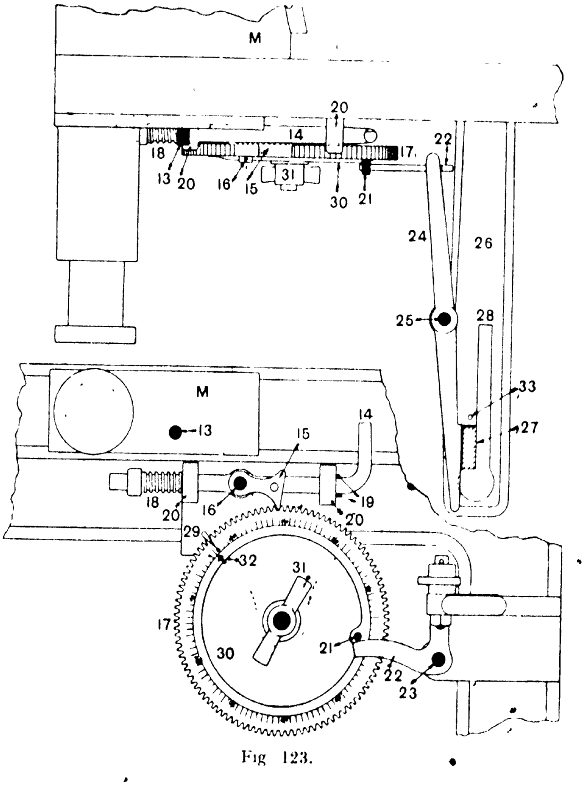


Fig 123.

to knock off at the next stroke. The arrangement is clearly such that the pointer 29 always indicates the number of lengths which have been cut at any period; and when the desired number has been reached, that number on the wheel 17 will be arrested opposite pointer 29 in virtue of the above-described automatic stop-motion.

Although the stated hand and machine methods of cutting bag lengths are available for nearly all kinds, some slight modification is required for bags or covers of special shapes, and for those made from certain light fabrics. Thus it is difficult to cut by the ordinary processes some of the very light and open fabrics intended for onion and firkin covers on account of the threads drawing. These cloths are sometimes cut on a vertical frame by means of a hand-knife, which is guided as usual by a slot. The piece of cloth is doubled over and over, and pinned to two sharp pins—one on each side of the vertical slot—and all the folds are then pressed together by a clamp before they are cut.

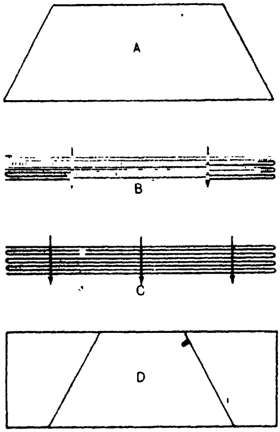


Fig. 124.

It is sometimes necessary—say, for cloths intended to cover sides of beef or for similar purposes—to cut the cloth somewhat similar to A, Fig. 124, where one side is longer than the other. It is obviously impossible to obtain such shapes by means of the power sack-cutting machine as at present arranged; but such cloths may be cut on the machine or frame illustrated in Figs. 112 to 117, provided the knife support D is arranged to oscillate about its fulcrum H until it assumes the desired angle on both sides of its present position, and that corresponding slots for the knife be cut across the table at the same angle, or that the part of the table containing the slot may be moved from side to side with the knife support.

Another method of cutting all sizes of bags is to fold the cloth on the folding machine illustrated in Figs. 76 to 78 (*see* pp. 97-102), then draw the piece on to the cutting table, mark it across at the desired places, arrange these marks successively over the slot in the table, and then cut by means of a strong hand-knife. Thus the piece may be folded so that three or four lengths may be cut as indicated at B and C (Fig. 124), the vertical arrows indicating where the several layers are to be cut; the end parts appear to be only half the length of the middle ones, on account of being doubled over. Diagram D in the same figure shows that if the folded pieces be marked on the angle, the irregular-shaped lengths illustrated at A may be cut with comparative ease. There are several types of irregular-shaped lengths which must be cut by hand.

# CHAPTER XI

## SACK OR BAG SEWING-MACHINES

SACK OR BAG SEWING. This very considerable branch of the finishing and making-up side of the jute textile industry was, up to about thirty years ago, performed almost entirely by hand. Gradually, however, the ordinary lock-stitch machine was introduced for hemming purposes that is, for stitching in the raw or rough edges of the fabric when these formed the mouth of the bag The same machine was also occasionally used for making the seams along the side and bottom of small bags, as well as for similar seams of bags made from light-weight cloths. The nature of the lock-stitch mechanism, however, prohibits excessive speed, and frequent stoppages must be made for changing the shuttle ; hence the productive capacity of the machine is limited. Although this type of machine sewing was a distinct advance on hand-work for several kinds of bags, the type of stitch a most desirable one, and the thread strong enough for a great number of cases, it was early recognised that some parts of the lock-stitch mechanism were not quite suitable for use in what was considered an ideal machine for the sack-sewing industry. For some time it was thought unlikely that the overhead stitch of the hand-sewer could be satisfactorily performed by machine ; but, as on many other occasions, the skill of the mechanical inventors has proved equal to the occasion, for it is now possible to introduce almost any kind of stitch by mechanical processes.

It may be taken for granted that up to about thirty years ago practically all sack sewing was performed by hand labour, and that most of the work was of a casual type. The cloth, as at present, was cut up into the required lengths at the works of the manufacturer or finisher ; these lengths were then bundled roughly into lots of 25 or 50, and handed out virtually to all and sundry who cared to sew. Some families—parents and children alike—did practically nothing else, and many of the wives of respectable tradesmen also took in sewing occasionally in order to augment slightly the rather lower earnings of that period. Flax or jute thread, according to the kind required, was supplied in sufficient quantity with the cloths, but, since all the sewing was done at home, all needles, thimbles (home-made, of leather) and "palms" for the protection of the fingers and hands, had to be found by the sewer. Payment was naturally made on the piecework system, and a strict inspection of all work had to be made to ensure that the sewing was regular, and that the stitches were of sufficient depth and closeness. At the present time, however, hand-sewing forms a very insignificant proportion as compared with that done by one or other of the different types of sewing-machines, and it is resorted to chiefly for the heaviest types of bag for an extra seam alongside of a machine-made seam, or for those few cases where it is more convenient to do the work by hand than by machine. There are few cases, however, even of the heaviest type, that cannot be performed by machinery.

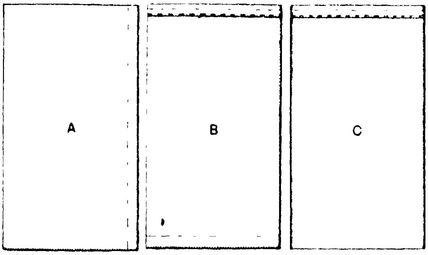


Fig 125.

Jute cloth, as well as cloth of other material, may be made into bags in different ways, and at A, B, and C (Fig. 125), we illustrate the three chief ways. Of these three, the ones at B and C are usually adopted.

To simplify the description, we shall assume that the finished bag in each illustration is 22in. wide and 40in. long.

In diagram A the length of the bag is formed from the width of the cloth, and there is therefore a selvage at the top, and one also at the bottom, and no hemming is required; but the bottom and one side must be seamed. If the overhead seam is to be used, the cloth should be about 40½in. in width to allow for the roll of this particular seam, otherwise the length of the bag would be slightly under 40in. The width of the bag is formed by cutting 46½in. from the cloth –44in., or 22in. on each side, plus 2½in. to permit of a turn-in or lay-in of the cloth at the side where the two edges are to be joined for the seam. When the bag is to be sewn by the chain-stitch the same lay-in allowance would require to be made at the bottom as at the sides, and consequently the cloth would require to be 41in. wide. In many cases, smaller allowances are made.

In diagram B the seam is again shown at the side and at the bottom, but there is also a hem at the top. The raw edges are therefore at the top and bottom of the bag, while the selvages come together at the side seam. The width of the cloth for this type is made twice the width of the bag, or 22in. × 2=44in. full to allow for the roll of the overhead seam, and the cloth is cut 40in. + 2½in. =42½in. long to allow for hemming at the top and the lay-in at the bottom. If the chain seam be used, then the cloth should measure at least 45½in. wide, so as to allow sufficient for the lay-in of that type.

Type C is made from what is termed narrow cloth, the width of which is practically the same as that of the bag. Seams are formed up both sides after the tops have been hemmed. The cloth is slightly wider than the width of the bag if for overhead seam, and the lengths of cloth are cut twice the length of the bag plus the allowance for hemming, or (40in. × 2) + 2½in. = 82½in. This type is obviously more expensive than the other types, since narrow cloth is proportionately more expensive to weave than wide cloth, and more sewing is also required—two side seams as against side and bottom seams in A and B, and hemming as in type B. It is almost entirely restricted to narrow, heavy, and strong twilled sacks, such as are used for coals, Portland cement, and the like. Type B is probably the most widely used form; it entails the cost of hemming when compared with type A, and also requires slightly more cloth than that form; but it makes a stronger bag, since the wrap is the long way of the bag, and a bag which is hemmed at the

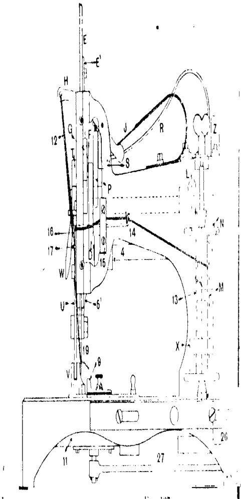
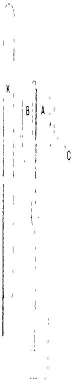


Fig. 127.



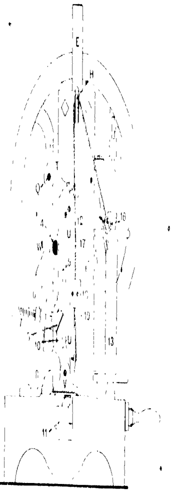


Fig. 129

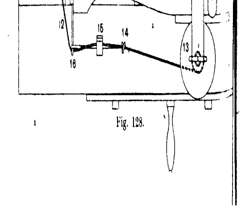


Fig. 128.

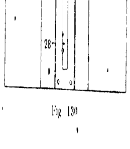


Fig 130

mouth lasts longer and is handier than one in which the selvages form the mouth.

The hem may be formed either by the lock-stitch or by what is known as the "Yankee" chain seam; but in each case the ordinary method of turning in the raw edge is the same (that indicated at D, Fig. 126), sufficient cloth—say, 1¼in.—being allowed to provide a hem about ⅜in. wide. This is always arranged to be on the outside of the bag when the latter is completed.

When the lock-stitch or the chain-stitch is used for side or other seams, however, it is possible to arrange them as desired in one or other of two different ways: (*a*) In which the seam is displayed on the outside of the finished bag, (*b*) in which the seam is turned to the inside of the bag when completed.

The latter method is probably the more common, it is slightly easier to manipulate the cloth by this method during the stitching process, and, since the bag is then turned inside out, the seam is better protected in the finished state. These forms are indicated at E, F, and G. The overhead machine may produce a practically flat seam, as at H, which is most suitable for those cases where the edges of the cloth require to be turned in; but where the sewing is to be done on the selvages of narrow cloth, it is much firmer if a rolled seam as at J is made.

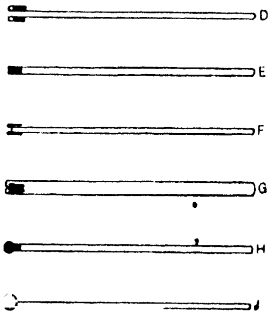


Fig. 126

Although the lock-stitch machine is deficient in some respects, notably that of being a comparatively slow-running machine, it yet possesses one outstanding feature which is in itself sufficiently important to form a powerful recommendation. As the name of the machine implies, the two threads which form the stitch are, when properly united, so perfectly interlocked that they cannot be separated, nor can the seam loosen by any reasonable amount of ordinary usage. Hence for permanent work, such as ordinary hemming, for which such machines are largely used, the lock-stitch form is superior to those chain-stitches where the threads are more or less imperfectly locked together. When the security of the stitch is of secondary importance, the quicker-running machines are more economical solely on account of their higher productive capacity.

All lock-stitch machines have their main features in common, which consist of a needle movement by which the top thread is forced through the plies of the fabric to be stitched, and a secondary part of this movement which causes the needle thread to slacken and to form a loop under the fabric, and through this loop the bottom thread is passed. Further, in most cases the bottom thread is wound in relatively short lengths upon a spool, or in cop form, and placed in a shuttle which is reciprocated either horizontally or vertically, and caused to pass bodily through the loop formed beneath the fabric by the needle thread and a tension bar. After the shuttle with the bottom thread has passed through the loop, the needle thread is withdrawn from the plies to the upper side of the fabric, and in so doing draws the shuttle thread also partly through the cloth. A perfect stitch is formed by so adjusting the tensioning devices which act upon the two threads that the interlocking point of the latter remains near the middle plane of the fabric. Some lock-stitch machines have no moving shuttle, but instead a hook mechanism which carries the loop of the needle thread round the spool containing the bottom thread. In this case the spool simply rotates axially in its receptacle as the thread is withdrawn under tension. All machines are also provided with a feeding mechanism by which the cloth is intermittently advanced step by step according to the length of the stitch desired.

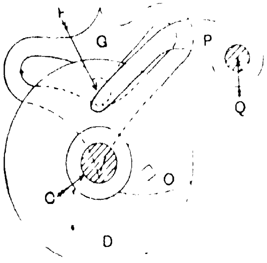


Fig. 131

The chief parts of one form of lock-stitch machine used extensively for hemming jute bags are illustrated in Figs. 127 to 133 inclusive. The first four of these figures represent respectively elevation of feed side, general plan, end elevation, and a detail plan of the cloth guide and the shuttle-carrier recess. All such machines for bag sewing are naturally driven by mechanical or electrical power, and motion is imparted to the above machine by means of ordinary loose and fast pulleys A and B, the driving belt being controlled by an ordinary belt fork.

*Needle Movement.*—The main shaft C extends through the machine, and carries at the extreme left-hand end a disc D (*see* enlarged view in Fig. 131), which imparts the necessary up-and-down movement positively to the vertical needle bar E through the medium of a crankpin F and a curved cam-slot in part G, to the latter of which E is fixed. As shaft C rotates, the revolutions of pin F cause the cam G, and therefore the needle bar E and needle 19, to rise and fall every revolution of the shaft C This carries the top thread 12 through the various layers in the well-known manner, and again returns it to the top side, clear of the fabric, to permit of the work being advanced for the next stitch. The secondary or looping movement of the top thread, when on the underside of the cloth, is controlled by the needle bar E and the tension lever H, through the extreme end of which the top thread passes on its way to the needle. The lever H passes through a slot in the needle bar E, is fulcrumed on a pin in the machine frame or arm, and its rear end is acted upon by a strong curved spring J, secured to the machine arm top. As the needle bar E descends, it forces down the lever H, and immediately the latter commences to fall it slackens the thread, and continues to do so until the needle reaches its lowest position. After the needle arrives here, it is raised about ⅛in. to form the loop for the tip of the shuttle. The shuttle now enters the loop, and in doing so it pulls the slack thread. The lever H then commences to rise again, draws the thread tight, and also pulls more thread from the bobbin 13. As the needle bar E rises, spring J returns lever H to the top position, so that the thread may be made taut previous to the succeeding stitch. An adjustable slotted bar on needle bar E, and a slot in the frame, regulate the extent of the upward movement of lever H. The needle thread 12 may be drawn from a spool or bobbin 13, as indicated in Figs. 127 and 128, or it may be obtained from other similar and convenient sources of supply. It is, however, tensioned in this case by passing through the wire eye 14, behind plates 15, through eye 16, upwards through eye in lever H, then downwards through eye 17 and guide 18, and finally through the eye of the needle. The plates 15 are spring-fixed on their supporting wire, and may be tilted more or less in order that the tension on the needle thread may be increased or decreased as desired.

*Shuttle and Shuttle Movement.*—For this particular machine the under thread is first wound in cop form, and then placed in the shuttle, four separate views of which are shown in Fig. 132. Views 20, 22, and 23, the last of which is an end elevation of view 20, show very clearly the method of threading, while view 20 shows the shuttle or cop lid 24 partly open. No. 22 shows the inside of the shuttle with the cop in position, but with cop lid 24 removed. When threaded the shuttle is placed in the shuttle carrier 11, as shown at 25. The relative positions of shuttle and needle are better indicated in elevation and plan in Figs. 129 and 130, as well as in the elevation of the delivery side (Fig. 133 and sectional end elevation Fig. 134). The shuttle and shuttle carrier 11 move to right and to left in unison with the rising and falling of the needle by means of the following gearing. At an intermediate point on the main shaft C a bevel pinion L gears with and drives an equal bevel pinion N on the vertical shaft M. The latter at its lower end is provided with a crank disc and pin 26, which, by means of connecting rod 27 (Fig. 127), imparts the necessary reciprocating movement to the shuttle carrier as the shaft M revolves. Both carrier and shuttle are supported and guided in their to-and-fro movements by a slotted guide plate 28 (*see* Figs. 130 and 132).

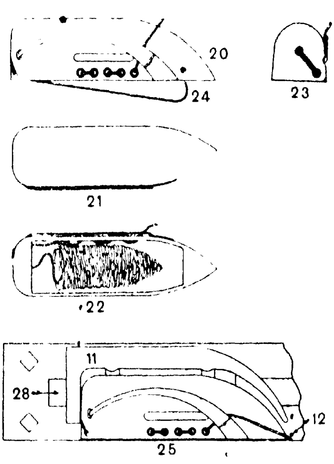


Fig 132

The cycle of stitching movements is similar to those in most domestic lock-stitch machines. When the needle reaches its highest point, as indicated in the figures, the shuttle is at the extreme right of its travel; and correspondingly, when the needle is at its lowest point, the shuttle is on the extreme left, with the nose of the shuttle just to the left of the needle, and ready to enter the loop as soon as the latter is formed. As the shuttle returns from left to right, the needle thread 12 is sufficiently slackened by a slight upward movement of the needle to allow the tip of the shuttle to pass between the thread and the needle, as shown at 25 in Fig. 132. Further movement of the shuttle to the right causes thread 12 to slip along the curved point of the shuttle and behind it, and ultimately to pass between the shuttle and the carrier 11, and then to slip round the blunt end of the shuttle so that it may be drawn upwards again through the cloth by the needle. The times of the different movements with relation to a fixed point on the rim of the balance wheel will be best understood by reference to the

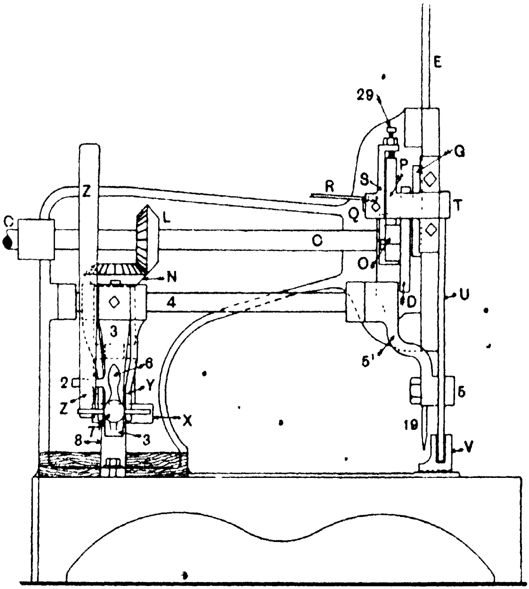


Fig 133

table on p. 171, and to the diagram in Fig 135, which shows a complete revolution of that wheel as viewed from the driving end.

*Feed Movement.*—In some machines this function is performed by a positively moved foot acting under the cloth; and in others, as in the machine under notice, by a more or less negatively controlled foot acting upon the top of the fabric. The feed motion is in two parts, one arranged to traverse the serrated foot V and the fabric forwards, or to the left in Fig. 129, through the necessary distance for the length of the stitch, and the other to raise the foot V clear of the fabric for its practically instantaneous return to the original position. Both returning and downward movements are controlled by springs. The forward traverse is procured as follows: The foot V is fixed as shown to the lower end of the pendant bar U (Figs. 127, 129 and 133), and the bar in turn is flexibly connected to arm T, secured to and rocking with the stud Q. Immediately above foot V, bar U is provided with a slot 10 through which a stud 5 passes from the end of the curved lever $5^1$ fixed to and rocking with the movement of shaft 4 (Figs. 133 and 134). On the rear end of shaft 4 are two levers Y and 3, the former of which is acted upon by the snail cam X (Fig. 136) fixed to the lower end of vertical shaft M. The lower or free end of lever Y is forked to embrace lever 3, which is set-screwed to shaft 4, therefore, as cam X revolves, levers Y and 3 are pressed outwards, shaft 4 is oscillated slightly, and through lever $5^1$ a similar movement is imparted to arm U and foot V.

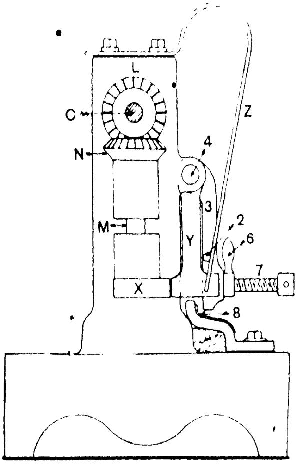


Fig 134

Levers Y and 3 are returned to their original positions by the action of the spring Z upon the stud 2 which projects from the side of lever 3. From the form of the cam X, as shown in Fig. 136, it will be evident that the outward motion of levers Y and 3, and consequently of the foot V, will be of a gradual nature until the extreme position is reached, but that after the dwell of the cam has passed, the return to the original position will be instantaneous on account of the sudden drop in the cam face. The extent of the movement of the foot V is regulated by the position of locking-nut 6 on adjusting screw 7 (Figs. 133 and 134). Cam X always presses lever Y outwards to the same position, and for the longest stitches the parts are so adjusted that lever Y, when farthest in, just reaches the boss of the cam X ; it therefore receives the full travel of the cam. For shorter stitches the position of lever 3 on the set-screw is so fixed that its lower end abuts against the leather stop 8, and thus prevents lever Y from reaching the boss of the cam to a greater or lesser degree. Cam X thus imparts a modified

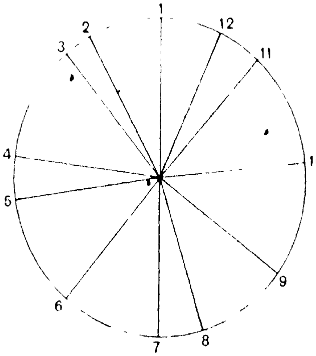


Fig 135

1 Needle 12 at highest point, and shuttle on extreme right
2 Tension lever H begins to move downwards
3 Needle 12 entering cloth
4 Foot V begins to move through the action of pointed cam O and lever P
5 Foot V at highest point, and ready for being dropped on to the cloth
6 Tension lever H at its lowest position, and shuttle on the extreme left
7 Tension lever H, after having been raised slightly, ready for dropping a little to facilitate the formation of the loop for shuttle tip to enter
8 Shuttle commences to take up part of the slack
9 Tension lever H at the bottom of supplementary movement explained under No 7
10 Needle thread just slipped over blunt end of shuttle, and tension lever H drawing thread tight
11 Needle leaving cloth.
12 Tension lever H stops at its highest point, and foot V beginning to move backwards

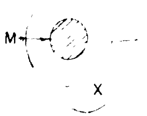


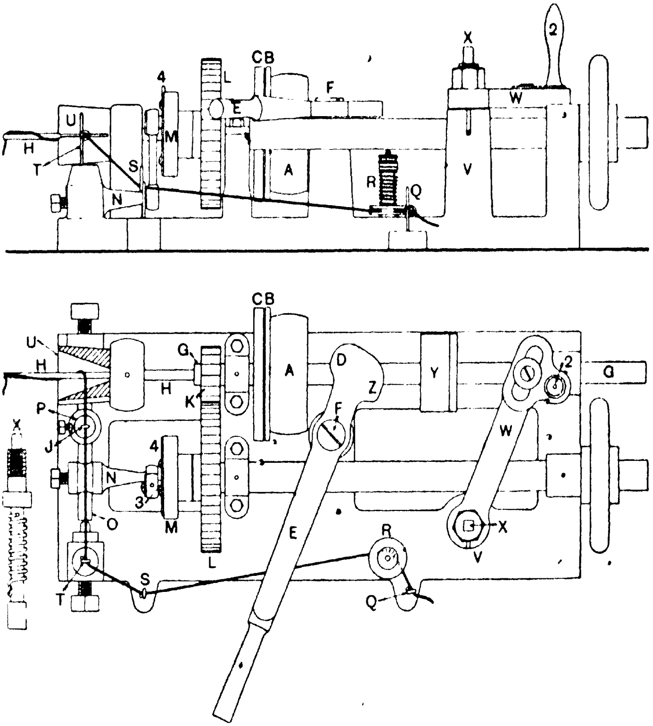
Fig 136

angular movement to Y and to shaft 4, and hence to foot V. The maximum and minimum stitches are about ⅝ and ¼in. Immediately arm U and foot V have completed their forward movement, the latter is raised clear of the fabric by means of cam O fixed to the disc D on shaft C, as shown in Fig. 131. As shaft C rotates, the cam O acts upon and raises the lever P, fulcrumed on stud Q. Stud Q therefore raises the lever T and pendant U (Fig. 129), and consequently lifts the foot about half an inch from the cloth. The slot 10 in the arm U provides means for this movement, as well as for the above-mentioned forward and return feed movements.

On the same stud Q (Fig. 128), and parallel to lever P, is a second lever S, which is kept in touch with lever P by means of the strong curved spring R, secured to the machine arm top, and the adjustable set-screw 29 (Figs. 127 and 128). The pressure of R secures the immediate return of the foot V to the fabric after the cam O leaves the end of lever P, and by the adjustment of set-screw 29, which increases or decreases the gap between levers P and S at the top, the pressure of the spring R upon levers S and P, and therefore of the foot V on the fabric, is increased or decreased, provided the thickness of the cloth is constant. Provision is made on the front plate of the machine in the form of a finger lever W, whereby lever T and foot V may be raised at will for the removal of the hemmed cloth, and for the insertion of a new hem. The width of the hem is regulated by means of an adjustable guide 9 (Figs. 127 and 130).

Since nearly all bags and sacks are sewn with comparatively thick thread—thread considerably thicker than that which is used in ordinary or domestic sewing-machines—the small shuttle, spools or drums are unsuitable on account of the very small quantity of thick yarn which they would hold. It is therefore usual for this heavy type of sewing to substitute a cop, as shown at Fig. 132, which, although small compared with the cops used in weaving, is about 2½in. long by ⅞in. diameter. Special cop machines are built for winding these cops, and they may be driven electrically or mechanically. Sometimes the ordinary fast and loose pulleys are used ; but the cop machine, which we illustrate in Figs. 137 to 140, is driven by friction.

Fig. 137 is a front elevation, Fig. 138 a plan, Fig. 139 an end elevation, and Fig. 140 shows a few details of the machine. A narrow belt from a drum drives the small pulley A, to the inner side of which is fixed a friction disc B. When disc B is clear of companion disc C, the machine is out of action, but if part D of



Figs 137 and 138

handle E, fulcrumed at F, be pressed against the side of pulley A, the latter and disc B are moved towards disc C, and the friction generated by the pressure is sufficient to rotate shaft G, and also spindle H, which is secured to or forms part of the shaft G. The spindle H is thus driven direct, but the oscillating yarn guide J is driven from shaft G by means of wheels K and L, eccentric disc M, lever N, shaft O, and yarn-guide support P. The yarn or thread comes from any convenient source, is passed through guide Q, and between the discs of the patent tension device R; it is then taken through two other yarn guides S and T, and finally through the oscillating yarn guide J to the spindle H. The cop is built, as most jute and flax cops are, by the tapered sides of the cone U, shown in section in Fig. 138; and the necessary pressure between the cop and the cone, to ensure a compact build, is obtained by a spiral spring in the pillar V, which, through lever W, fulcrumed at X, has a tendency to hold the spindle, or rather the cop, hard in contact with the inner part of the cone U. A detailed view of this spring and its position on the stud is shown in a detached figure to the left of Fig. 138. As the cop is built by successive layers of thread, the spindle H, shaft G, and collar Y are drawn forward or pushed to the left until the desired amount has been wound. Part D of lever E is then removed from pulley A, thus stopping the spindle, and at the same time the part Z of the same lever is pressed against collar Y, which, when the cop is made is very near to Z, and handle 2 of lever W pulled to the right, by which means the spindle is withdrawn from the cop.

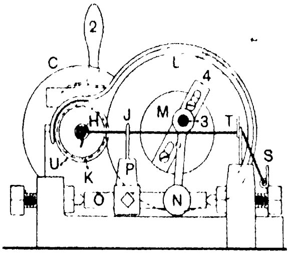


Fig 139

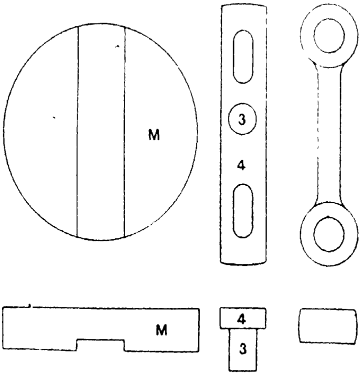


Fig 140

The travel of the oscillating yarn guide J, and therefore the diameter of the cop, is regulated by the position of the stud 3 on slide bar 4; the disc M is grooved, as shown in Fig. 140, in order to admit of this movement, and to hold the slide bar 4 securely in position, while the oscillating yarn-guide support P may be adjusted on rocking shaft O, so that a satisfactory cop may be built.

The ordinary machines for hemming are in general adapted for using comparatively thin or fine yarns spun from the fibres of cotton or of flax; but for certain heavy bags it is almost essential that a thicker and cheaper sewing thread should be used. Machines are therefore made in which heavy jute twine may be used for making the above-mentioned hems; but it is scarcely necessary to multiply examples of hemming-machines, since they all work on much the same lines. It may be mentioned, however, that the hems made

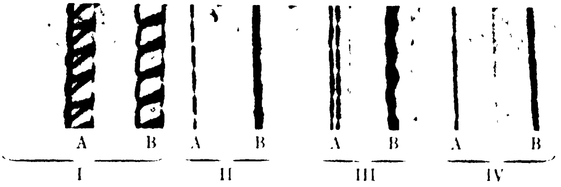


Fig 141

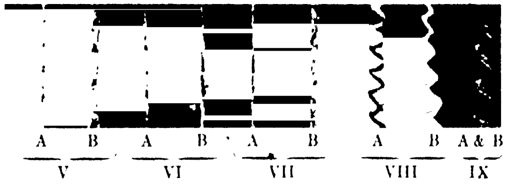


Fig 142

I. New type of overhead seam or "Union" overhead seam, invented and introduced to imitate the ordinary overhead seam and to increase production
II. The Yankee seam or Union seam
III. The Union double-thread hem
IV. The Union single-thread hem } These are practically identical
V. The Singer single-thread hem }
VI. The lock-stitch hem
VII. The Union or Yankee seam
VIII. A zig-zag or cross stitch, which also forms an overhead seam
IX. The ordinary overhead seam made with the Laing machine

with heavy twines are not of the lock-stitch type, but are more or less of the chain-stitch form. The different types of hem stitches are formed sometimes with a single cotton, flax or jute thread, sometimes by the lock-stitch, and sometimes with two threads of cotton, flax or jute.

Before proceeding further with the description and illustrations of other typical machines used for jute, linen, and cotton bag making, it will perhaps be best to give a brief definition of the various kinds of stitches used. In order to show up the stitches distinctly, we have prepared small samples of white cloth with black and red sewing threads, and similar small samples of black cloth with ordinary flax and cotton sewing threads. These samples are illustrated respectively in Figs. 141 and 142.

In all cases where both sides of the cloth are shown the letter A represents the stitch as it appears on the top side of the seam, while letter B indicates the appearance of the seam on the underside.

Although relatively wasteful of thread, it is generally conceded that for most classes of work the Yankee or Union machine is unsurpassed; and although the stitch made with the machine is certainly of a chain type, and is therefore capable of being pulled out, yet on the other hand it possesses the following important advantages:—

(*a*) A workable speed of 1800 to 2000 stitches per minute.
(*b*) Both threads may be withdrawn from rolls, balls, or similar shapes which hold enormous lengths of yarn.
(*c*) Few stoppages, on account of being able to use rolls, etc., instead of shuttles.
(*d*) May be used both for hemming and seaming.
(*e*) Durable material and highly finished and standardised parts, thereby ensuring the minimum of breakages and a high economy in renewals and repairs.

The machine as now made appears as near perfection as it is possible to reach, but even twenty or thirty years ago its merits were so pronounced that it easily obtained preference for the sewing of most classes of bags. It is now made by a few different firms, but the general principles are practically the same in all—any difference which may obtain being in minor details, material, and workmanship, and not in principle.

The action of the machine will be understood by reference to Figs. 143 to 146, which show respectively front elevation, plan of under parts, elevation of needle end with detached view of driving eccentric at opposite end, and detailed views of various parts. The modern method of driving these machines will be described and illustrated later in connection with a somewhat different type of machine, but in all cases the driving belt or band imparts motion to the grooved wheel A on the end of the main shaft B. Between the grooved wheel A and the framework of the machine is an eccentric C, the top end of the arm of which encircles a ball-joint D; this ball-joint communicates the up-and-down motion of the eccentric arm to the short arm of the three-armed lever E, fulcrumed a little to the left of D (Fig. 143). The longest arm of lever E is connected in the usual manner to the needle spindle F by link G and collar H, while the needle itself is fixed as usual to the lower end of the spindle F. The third and lower arm of the lever E is connected to one end of the rod J, the other end of the rod J is attached to the short lever K, which supports and carries the looper L.

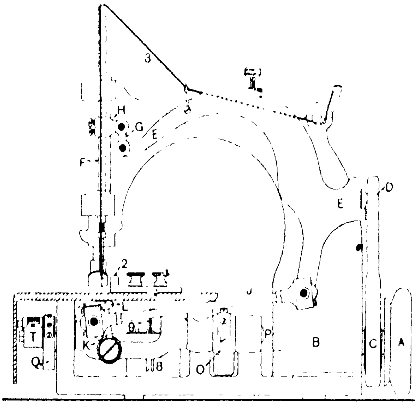


Fig. 143

*Movement of Looper.*—The up-and-down movements of the needle are similar to those of all sewing-machines, and need not be further described; but the movements of the looper are very important, since it is this piece of ingenious mechanism which dispenses with the use of a shuttle, and makes it possible to use practically any length of yarn, provided the latter is free from knots and satisfactorily wound on a spool, bobbin, or ball, and that it may be unwound from the latter free of kinks or curls.

The looper L has a forward and backward movement in addition to its movements from right to left, and *vice versa*. The eccentric C is in its lowest position; the needle is therefore at its highest point, and the rod J, together with looper L, is at the extreme left position. When the looper moves from right to left, it moves in a plane which is behind the vertical plane of the needle, *i.e.* nearer the delivery side of the machine; when it reaches its present

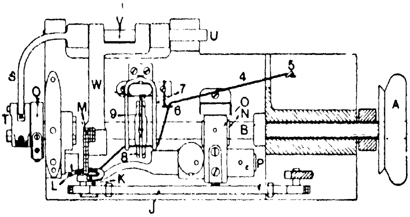


Fig 144

position on the left, it is rocked towards the operator, or the reader, so that its movement from left to right will be in a plane in front of the needle; finally, it rocks forwards—*i.e.* away from the operator—at the extreme right hand ready again for its movement to the left. During this cycle the looper moves in the track of a very flat ellipse, and the needle passes through the centre of the elliptical path thus described. The rocking movement of looper support or lever K is obtained by a small cam N (*see* Figs. 144 and 146), which elevates and depresses forked lever O, fulcrumed on the rocking shaft P, and thus conveys the necessary oscillating motion to arm O, and hence to the looper L. This complicated movement of the looper naturally synchronises with the movements of the needle, and is accompanied by the necessary feeding movement.

*Movement of Feed Dog.*—On the end of the main shaft B is fixed a disc Q provided with a slot so that the stud R (Fig. 145) may be secured at the proper distance from the centre of the disc Q to give the necessary eccentricity of movement to the arm S through the link T. Arm S is carried round the delivery side of the machine, and is fulcrumed on the rod U (*see* Figs. 144 and 146). Two arms at the upper part of S support the rod V, on which oscillates the feed-dog carrier W. The function of the feed dog M is that of drawing the cloth forward to present successively new parts for stitching. Its backward and forward movements are obtained as described through the action of the disc Q, and its vertical movements follow from the action of the small cam X on the shaft B (*see* Fig. 146), which is enclosed between the lower part of carrier W and the cranked arm Z, the latter part being set-screwed to the carrier W as shown.

The width of the hem is regulated as usual by a guide plate 2 secured by hand-screws to the upper plate of the machine; this plate is shown in section in Fig. 143, but omitted altogether in the remaining views, so that the other parts may be seen.

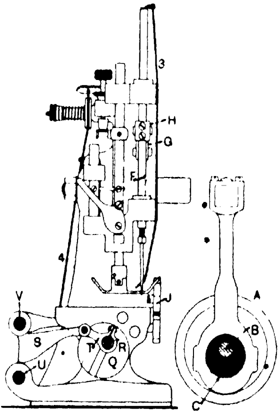


Fig 145.

*The two sewing threads.*—As already mentioned, both threads are drawn from balls or spools situated near to, but clear of, the driving wheel A. The path of the upper thread 3 is easily followed through the various guides and through the patent tension arrangement to the needle, and the path of the lower or looper thread 4 is almost as easily followed, although some explanation concerning this thread is desirable. It is first passed through an eye in the wire 5, and from there through the eyes of two projecting pins 7, then through an eye in the back part of looper L, and finally through a second eye near the point. Between the two pins 7 (Figs. 144 and 146) is placed the apparatus 8 for taking up the slack thread which is given off by the looper as it moves towards the right from its present position. This apparatus is sometimes termed the "take-up," and it will be understood by reference to Figs. 146, 147*a* and 147*b*, the latter two of which illustrate the looper L and the vertical needle in six different positions, as well as the corresponding positions of the take-up plates and the looping thread 4.

The first position, marked (1) in Fig. 147*a*, is the same as that shown in Figs. 143 and 146—that is, with the needle in highest position, eccentric on bottom centre, the looper on the extreme left, and the lower thread 4 straight between the two projecting pins 7. In position (2) the looper has moved about half its distance, and in doing so it is evident that the bottom thread will have become slack. Immediately the looper L commences its movement from position (1), the long flat part of the "take-up" plates 8 carries the bottom thread partially round, and thus takes up the slack which is given off by the looper. This continues until the thread reaches the stop wire or cast-off 9, which arrests the further progress of the thread, although the plates themselves continue to rotate as usual. During the continued movement of the looper L from the position (2) to the extreme right, the bottom thread 4 is still held in position, and the looper simply slides on the thread until it reaches the extreme right—position (5) (Fig. 147*b*).

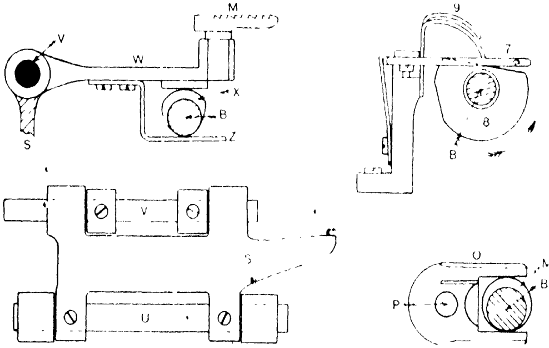


Fig 146

In position (2) the needle is just entering the cloth, and the bottom

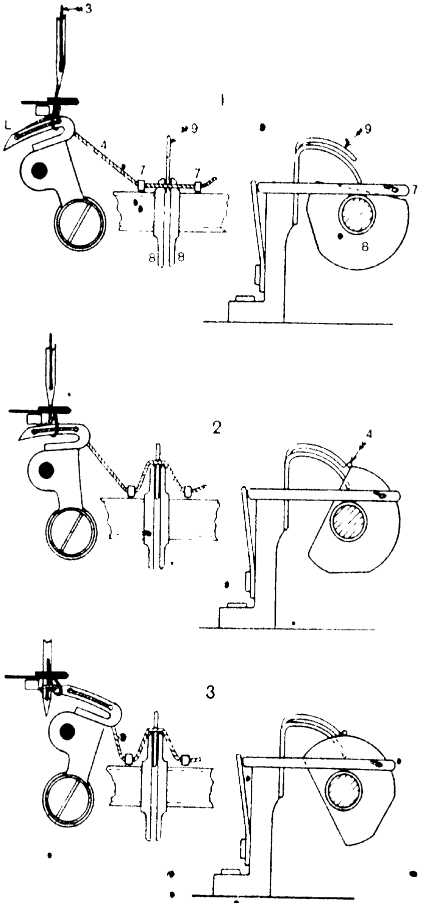


Fig 147*a*.

thread 4 stretches, as shown, from the point of the looper to the last complete stitch formed in the cloth.

Position (3): The needle with the top thread 3 has just passed through the loop formed by the thread 4 between the point of the

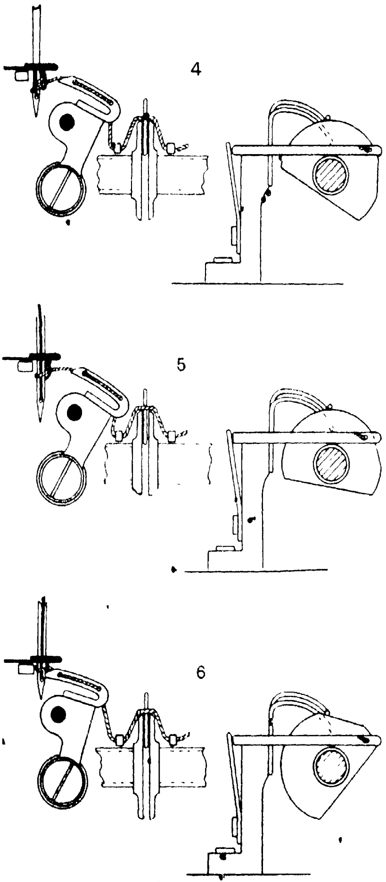


Fig 147 *b*

looper and the cloth, and the looper itself has passed in front of the needle.

Positions (4) and (5) show the further downward movement of the needle, and the movement of the looper to the right—both being in their extreme positions in (5).

The eccentric C is now in its highest position, the needle in the lowest position, and the looper L is just about to move towards the delivery side preparatory to starting on its forward journey from right to left and behind the needle.

Position (6) shows that the looper has moved into its forward position, and its point is just entering behind the needle, and between it and the top thread 3, thus holding the latter down as illustrated in position (1), the small flat part on plates 8 facilitating this movement.

The times of the various actions are indicated on the circle in Fig. 148—the circle representing the grooved wheel as viewed from the right-hand end of the machine.

Fig. 149 illustrates a large sewing flat fitted up with several Yankee sewing-machines, and the frames upon which the operatives turn the bags inside out after they are sewn. The photograph also shows one of the general methods of arranging the tables for these machines; the woodwork covers completely most of the under mechanism. The Singer Manufacturing Co., Ltd., have an excellent method of protecting the various parts of these and similar machines. The under part of their factory power table is quite open, and all shafts, wheels and the like are enclosed in tubes or cages as the case may be. They thus provide the maximum of room for the workers, freedom from contact with moving parts under the table, and best facilities for keeping the room clean and tidy.

The sewing thread used in the Yankee and similar machines is usually about three-fold 2½lb. flax line, although cotton thread of similar thickness is used for certain classes of bags. When, however, a very heavy sewing thread is required—as, for example that used for coal bags and similar articles—the thread is made from three-fold 7lb. or three-fold 8lb. jute, and the sewing is generally performed on what is termed the "Laing" machine. The stitch made by this machine is of the overhead type, and is illustrated at A and B, IX, Fig. 142, p. 175. Its special recommendation is that the sewing cannot be pulled down nor become unravelled in any way.

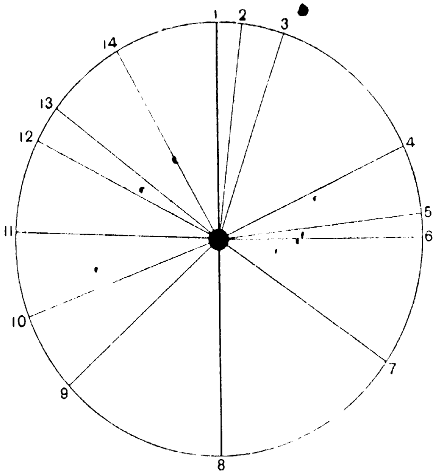


Fig 148

1 Eccentric at lowest position, needle at highest point, looper on extreme left, feed-dog at highest position and moving forward with the cloth, large flat part of " take-up " plates nearly horizontal

2 Flat parts of take-up plates perfectly horizontal and ready for taking the lower thread round with it when the thread is given off by the movement of the looper towards the central position

3 Looper has been oscillated to its full backward position and moving to right in a plane immediately in front of the plane of the needle

4 Needle entering cloth and opposite middle of looper, feed-dog commencing to drop, looping thread held by cast-off wire 9 on periphery of take-up plates

5 Looper thread entering on circular part of take-up plates, and feed-dog moving towards operator.

6 Needle entering loop formed by lower thread between cloth and end of looper, feed-dog at lowest point

7. Needle thread just slipped off the end of looper

8 Eccentric at top, needle at lowest point; looper on extreme right and moving forward so as to be ready to pass from right to left in a plane immediately behind the vertical plane of the needle

9 Feed-dog commencing to rise

10 Looper point passing behind needle and entering the loop between needle and needle thread

11. Feed-dog has reached its full back position nearest to the operator

12. Feed-dog entering on dwell for highest position and ready for moving forward to draw cloth in; needle leaving cloth

13. Looper thread enters on flat part to allow thread to be drawn forward by looper.

14 Looper almost on extreme left, and commencing to move to backward position nearest to operator.

Figs. 150 to 155 are illustrative of one type of this most ingenious machine, which, although slower running than many other sewing-machines, still holds first place for this heavy type of sewing. Its comparative slowness is due partly to the heavy nature of the work, and partly to the fact that the needle has to be threaded for each bag; but, in spite of this intermittent stoppage, the machine is capable of sewing 600 to 1000 bags per day, according to the size of the bag, and to whether the seams are at both sides, or at the bottom and one side only. The dry or tarred twine, as the case may be, is cut into lengths according to the size of the bag or the length of the seams, and these lengths of doubled thread are then suspended in different ways to enable them to be withdrawn singly by the operative. Fig. 150 shows clearly the suspended lengths for medium and very large bags, and it also gives a general idea of the appearance and arrangement of these machines in a modern sewing flat.

Fig 149

The working of the machine will be followed by reference to the line drawing illustrations, of which Fig. 151 is a front elevation; Fig. 152 shows a plan with covers or guards; Fig. 153 a similar plan with guards removed; Fig. 154 shows detailed parts;

while Fig. 155 illustrates the end framework, the main parts of the sewing mechanism with supports removed, and details of other parts of the machine. The belt A communicates motion to the fast and loose pulleys B and C, and to the main shaft D. A bevel wheel E on the end of the main shaft transmits the motion through bevel pinion F to wheel G, which is compounded with the first

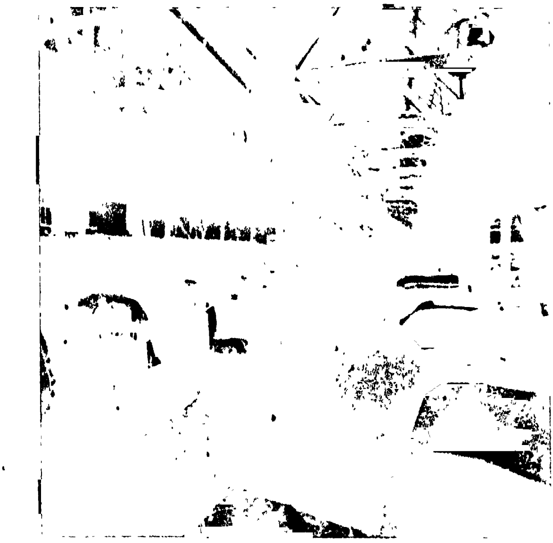


Fig. 156

cone needle driver H. Two similar cone needle drivers J and K are driven at the same speed as H by means of the skew intermediate wheels L and M and the wheels N and O, the two latter being compounded respectively with J and K. The three cone needle drivers G, J, and K grip the spiral needle P and rotate it counter-clockwise when seen from the end view in Fig. 155. The long length of thread is doubled and the doubled part placed on the hooked end of needle P, so that when the needle rotates, the thread is carried round and round the needle tube Q which encircles the outer portion of barrel

R It is, of course, essential that the cloth to be sewn should be carried forward a definite distance for each revolution of the needle P, this distance is usually about ⅜in, the pitch of the cone needle drivers, other pitches, however, are often used.

A table upon which the bags are kept in readiness for sewing (*see* Fig. 150) is stationed near the machine, and the attendant inserts the edge or the bottom of the bag into the opening S (Figs. 151 and 152). Since the face of the moving chain T is formed of serrated sections (four enlarged views of which appear in the right-hand detached figures, Fig. 151), and the under surface of the top grip U is grooved to correspond and pressed down by means of enclosed springs in parts V, it follows that the bag will be drawn forward as the chain T advances. The method of driving the chain T is indicated in Fig. 153. On the main shaft D is fixed a wheel

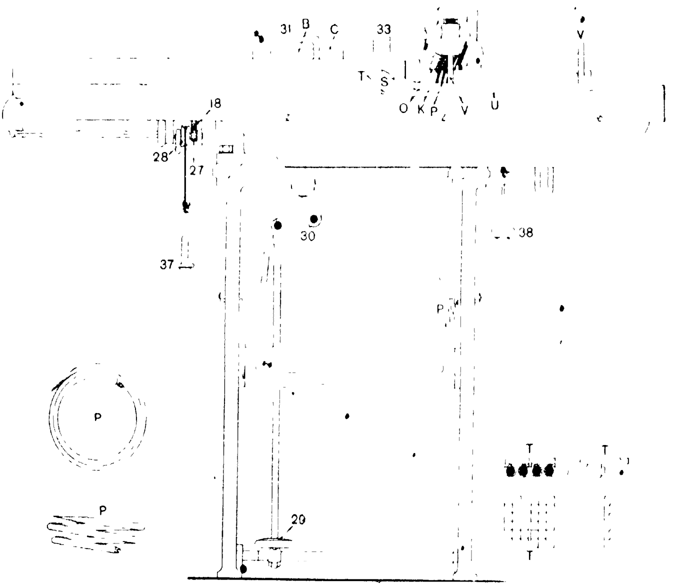
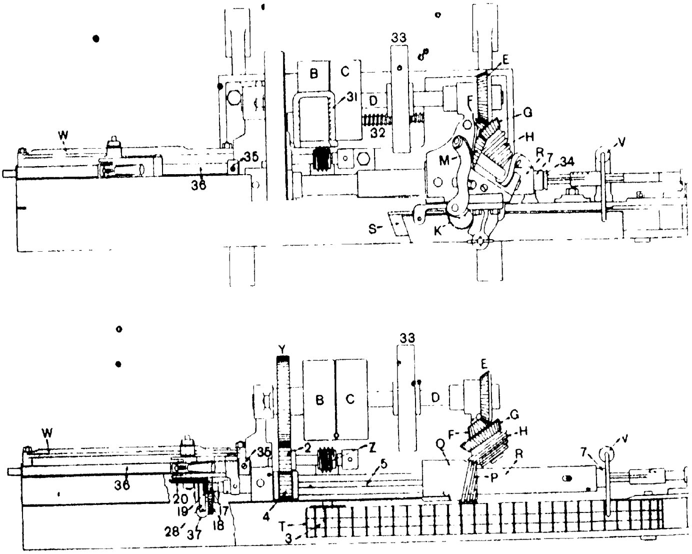


Fig 151

Y which drives worm Z through pinion 2; worm Z communicates its motion to a worm wheel immediately under the worm Z and on the end of a short shaft, which carries at its opposite end a sprocket 3. This sprocket gives the requisite motion to chain T. Pinion 2 also drives pinion 4, which runs loosely on barrel R, but which drives the latter by means of a key and a corresponding long groove 5 in the barrel R. The barrel R always rotates when the belt is on the fast pulley, but it moves to the left (*see* Fig. 153) only when two or more coils of the sewing yarn have slipped off the end of barrel R on to the inner tube 7. It will be an advantage first to describe how the inner tube communicates its motion to the rack which draws both barrel R and tube 7 to the left. In the detached drawings in Fig. 155 are illustrated four parts numbered 6, 7, 8, and 9, all of which also appear enclosed in and near the end of barrel R; these parts are in position, and most of them in section in detached drawing 10. Part 6 is composed of a block



Figs 152 and 153

which is set-screwed to the tube (in drawing 10 the part 6 is turned 180° to show this); an adjusting screw 11 passes through the centre and is kept in position by lock-nut 12. The part 6 fits into a rectangular opening in part 7, and a pin 13 fits into a corresponding opening in 7, so that both rotate with barrel R. The inside of 8 is formed to receive the cone 9, and a spiral spring encircles part of the shaft 14, by means of which the two parts 8 and 9 are normally kept separate or clear of each other. Collar 15 is simply a steadying part, while rod 16 is fixed to cone 9, and therefore revolves with it.

When the tension of the thread draws the inner tube 7 a little to one side, the base of 7 bears on the base of part 8, and forces the latter into close contact with cone 9. Under these conditions cone 9 and shaft 16 are rotated by the frictional contact between the inner and outer cones of 8 and 9. Fig. 154 shows the rod 16 as viewed from the back of the machine. When the rod 16 is in motion, which takes place only when two or more layers of sewing thread have slipped on to the inner tube 7, the small pinion 17 drives wheel 18 (Figs. 153 and 154), while a bevel pinion 19, on the same stud as 18, gears with bevel wheel 20, and thus rotates plate 21 centered at 22. Ratchet wheel 23 is compounded with rack pinion 24, and the boss of bevel wheel 20 and plate 21 fits into a socket in ratchet wheel 23. All move in unison when the machine is working, and the barrel R, together with all the enclosed parts, termed the carriage, is drawn back by the small rack pinion 24 rotating in the teeth of the fixed rack 25. The ratchet wheel 23

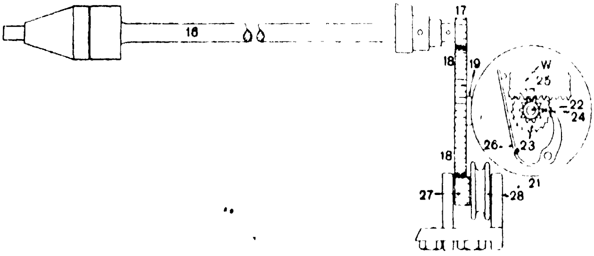


Fig. 154

and spring pawl 26 drive the rack pinion positively, but they are also intended to act as a flexible joint.

The operation of sewing is somewhat as follows: The cloth is inserted at S, and the operator presses down treadle 29 (Figs. 151 and 155), which through bell-crank lever 30 draws belt fork 31 over fast pulley C. The machine is thus put in motion, and the cloth drawn forward until the point of the needle P has entered the cloth. The treadle is then released, when spring 32 (Fig. 152), immediately places the belt on the loose pulley. The hand-wheel 33 is then rotated until the needle eye, or rather hook, is in a convenient position for receiving the doubled thread. Treadle 29 is again pressed down, and the needle P and barrel R rotate. Every revolution of needle P results in placing a layer of thread round the barrel R, but all layers rotate on the barrel, and make the same number of revolutions as the needle itself. There is thus little or no drag on the needle eye or hook. When the layers accumulate so as to fill the exposed length of barrel R (and this length will vary according to the length to be sewn), they begin to slip off the end of barrel R and on to the inner tube 7; ultimately, say when there are three layers on tube 7, the first one slips off the end and between it and the stop 34. This thread can be rotated no longer by the barrel R and tube 7, but is now drawn tightly around the edge of the sack, and thus forms the first stitch of the overhead seam. The barrel R and the inner tube 7 are now moving to the left, whereas the sack is moving to the right: hence the first overhead stitch is drawn tight. It is the pressure of the successive layers as they slip over the inner tube 7 which imparts the pressure to the latter, bringing the cones 8 and 9 into contact, and thus rotating the shaft, which in turn communicates its motion to the rack pinion. The carriage moves backwards about 1 inch for every 8 inches of sewing, and a plate or collar 35 (Figs. 152 and 153), may be moved along the bar 36, and set at the required distance, to act as a stop plate for the carriage for different sizes of bags. The handle at the top of the carriage is pressed down to move the rack pinion 24 out of gear with rack 25, when the carriage may be moved to the right, Fig. 151, ready for a fresh bag. This movement may be accomplished either by hand, or by weights which draw the carriage immediately the handle is depressed and the rack pinion withdrawn from contact with the rack. If the barrel R and tube 7 move back too freely, their movement may be retarded by adding a small weight at 37, which, through a cord passing over pulley 28, retards the movement of the pinion 27 and places a little more work on the cones 8 and 9. A reduction of weights acts in a contrary manner. Weight 38 is for the purpose of keeping part 34 (Fig 152), in contact with the tubes.

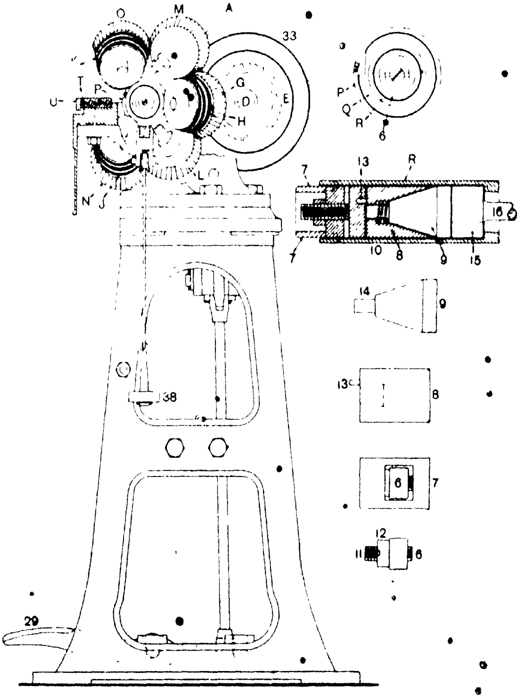


Fig 155

The latest development in this type of machine is that known as the M and M patent, model Z, and made by Mr D. J. Macdonald, South St Roque's Works, Dundee. One of the difficulties experienced in connection with overhead sewing-machines was that two or more different machines were required according to the strength of the fabric or the number of plies to be sewn together. This difficulty has been overcome entirely by the above-mentioned model Z, which is capable of sewing anything from single cloth calico to 10 or 12 layers of ordinary jute sacking. The writer has seen 10 thicknesses of such cloth, involving a ⅞in. thick seam, sewn with this machine. Moreover, no alteration in the tension device is necessary for the different numbers of layers or the different weights of cloth. Of course we may say at once that ten layers are never required in practice, but a machine which is capable of performing this work can easily sew four layers, which is the usual maximum number of layers. The four plies of heavy type hemp cloth is perhaps the most severe test which is demanded, and the machine sews this quite easily.

One improvement which has helped considerably to make this machine a success -and between 200 and 300 machines have been ordered and made since March 1914 is the introduction of three direct pressure hammers in place of the usual bends and enclosed springs; while a further improvement is that of placing the cones so as to prevent the needle from being forced out, and at the same time giving a maximum amount of room for the cloth

The row of machines illustrated in Fig. 150, also made by Mr Macdonald, are examples of an older but largely used type, while Fig. 156 is an illustration of the main parts of the modern model Z. The above-mentioned direct pressure hammers, or at least two of them, are clearly seen in contact with the partially-sewn cloth. This photograph was taken specially to illustrate the cloth in progress, and to show the spirals of sewing on the barrel. Seven spirals are shown clearly on the barrel, and two on the friction tube or nozzle, while the finished stitches are plainly visible on the edge of the fabric.

The carriage, which differs from that already described, is illustrated in detail in Fig. 157. The complete carriage is shown in the upper part of the figure, while the details, drawn twice the size of the complete figure, appear immediately under. When the carriage is moving to the left, it does so in virtue of the screw A on rod B rotating between two split-gear nuts, the pressure or

Fig. 156.

grip of which is horizontal and does not affect the grip of the friction cones. In some machines a half screw nut is employed, and the screw is supported by, and slides along, a half bush as it is moving backwards between the bush and the half nut. To bring the carriage to the extreme right, the above-mentioned split-gear nuts are quickly separated by means of two diverging slots in the upper extensions of the split nuts, and two pins which enter the slots and cause the nuts to separate when a small handle is pressed downwards. When in work the nuts are kept close by means of the pressure of a spiral spring.

The advantage claimed and sustained by the new carriage is the rapidity with which the rod B and all parts can be moved for slight obstructions, such as dust, which enter between the cones and other parts enclosed in the barrel C. A small pin D passes through the adjustable collar E and the rod B, hence, when this pin is removed, all the parts may be drawn out of the barrel C, the dust removed, and the parts replaced in a very short time, and this may be done at the machine. The complete carriage consists of the following parts in addition to those mentioned:—

Inner cone F screwed to rod B and extension G.
Friction cup H, right-hand end view $H^1$.
,, nozzle J, ,, ,, ,, $J^1$.
Round nut K, ,, ,, ,, $K^1$
,, lock nut L, ,, ,, ,, $L^1$.

while all parts are shown in position at M.

The screw N is for the tension pulley. A strap hangs over this pulley, and weights are added to obtain the desired tension.

A feather key in tube drives the barrel C by means of the long keyway shown, but the rod A, and the barrel, commence to move laterally only when the friction nozzle is pulled by the tight sewing, in which case the rotating friction cup H drives the cone F and the rod B. The friction nozzle J should be oiled at O at meal times so as to prevent heating up between the nozzle and the round nut K. The latter and L are adjusted by suitable keys; they are screwed up to make a slack stitch and screwed back to make a tight stitch.

The position of the barrel or the exposed part at the right of the machine depends upon the length of bag to be sewn; in other words, for the longest length to be sewn the greatest distance must the barrel travel backwards. The number of spirals on the barrel multiplied by the circumference of each spiral equals the length to be sewn, and when the barrel is fixed for any particular length, an adjustment nut is placed on the guide rod under the barrel so that the latter may always be brought forward to its proper place for the commencement of each length of sewing. A sliding knife moves with the barrel and cuts the thread when the sewing is completed. The machine is driven by 3½-in. pulleys, and two hand wheels, seen in Fig. 157, are supplied to turn the machine by hand ready for threading the needle, the eye or hook of which should be just opposite the starting end of the bag. It should also be noticed that the eye or hook of the needle is not outside the edge of the cloth when it is threaded, but that this end of the needle is in the cloth; otherwise the thread will break immediately the machine is started.

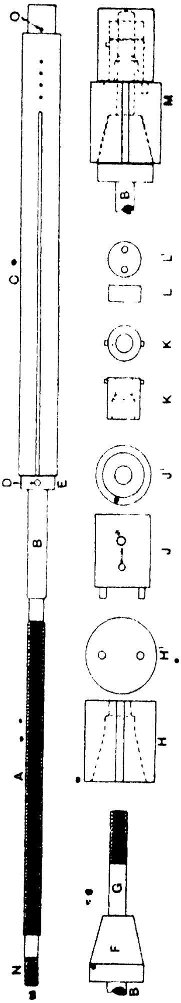


Fig. 157

Figs. 158 to 161 illustrate a machine which, by clever and ingenious mechanism, is capable of making a seam more or less like that of the overhead seam; indeed, the machine has been invented to form a stitch intended to compete with the perfect overhead seam formed by the Laing machine. Fig. 158 is an elevation of the delivery side, and Fig. 159 a plan with all parts above the foot removed; while Figs. 160 and 161 show respectively elevations of the feed side and the sewing end, together with details of the driving mechanism, which is practically of the same type as that used

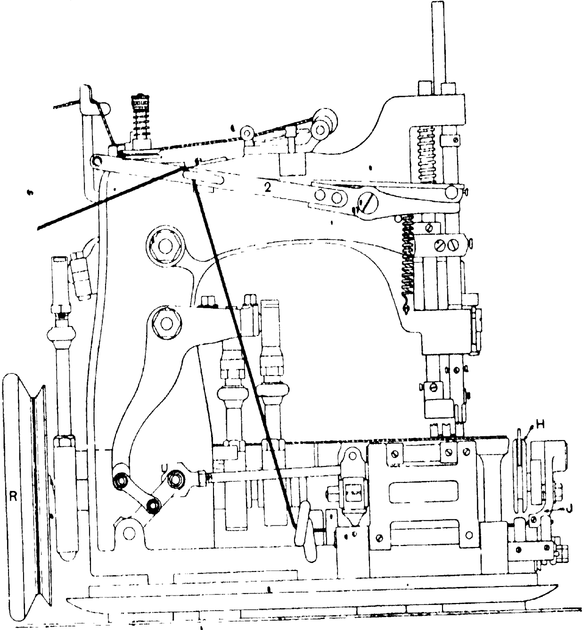


Fig. 158

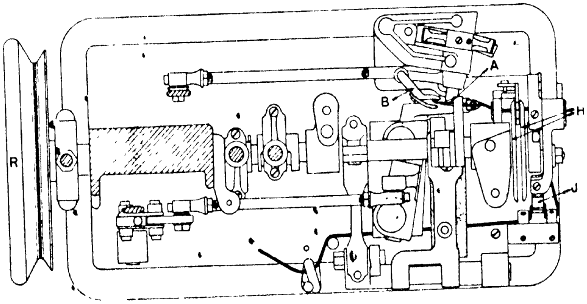


Fig. 159

for driving the Yankee machine illustrated in Figs. 143 to 148

The machine under notice is also similar in many respects to the Yankee, differing from it principally in that it possesses two loopers instead of one, with the necessary mechanism to drive the second looper; that the tension devices, take-up and pull-off mechanism, are of a modified form, and that both loopers are driven by eccentrics. The upper parts of the machine need no reference because of this great similarity, but the lower parts, from which the covers have been removed, call for some explanation.

The under looper A performs the same function as the one in the Yankee machine, but it also works in conjunction with the overhead looper B. The latter is caused to move to and fro through rather more than half a circle around the edge of the cloth by means of eccentric C, lever D, rod E, and toothed quadrants F and G, and in doing so to carry a loop from the thread of under looper A on the under side of the cloth, round, and over the edge, and beyond the needle at the top side of the cloth. While the overhead looper is in this latter position, the straight needle enters the loop, passes through the cloth, and thus retains the looped thread on the upper surface. When the needle again leaves the cloth, the thread holds the loop permanently, since the needle thread itself has meantime been locked on the under side of the fabric by the under looper A passing between it and the needle. It is essential that the sewing twine should be given off at the proper time to allow sufficient length for over-edging or whipping the edge of the seam, and this is done by means of the take-up discs H, while the yarn is drawn from the bobbin by the pull-off motion J. The directions taken by the two sewing threads will be easily traced, and their various movements followed with respect to each other, from the undermentioned particulars. The direction is clockwise as viewed from end of hand-wheel R: –

20° Needle thread slips off the end of under looper
45° Feed dog leaves cloth
48°. Straight needle entering loop formed by the overhead looper
60°. Overhead looper on the extreme left, straight needle entered loop formed by the overhead looper, thread retainer or hook holding up needle thread
80°. Straight needle entering cloth
85°. Under looper at extreme left
100°. Take-up discs come in contact with thread.

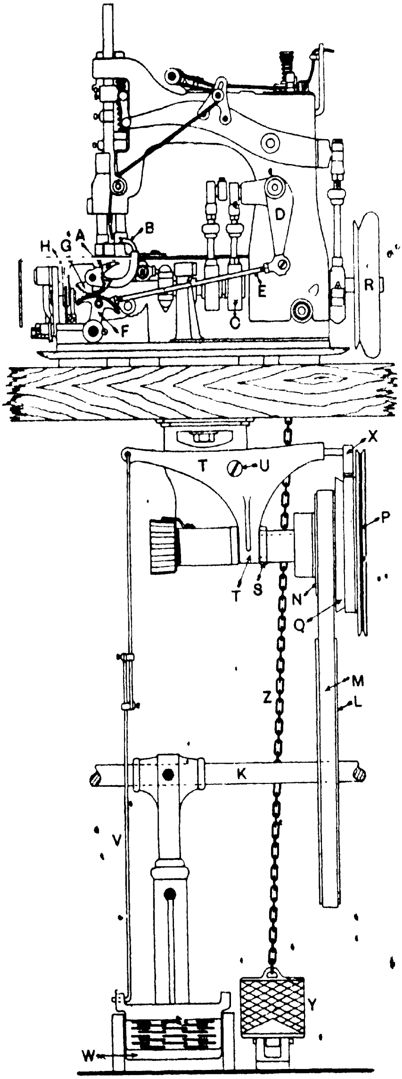


Fig. 160.

105°. Straight needle thread slipped off the back prong of overhead looper; take-up mechanism commences to act

120° Under looper thread slips off the fork of overhead looper.

150° Under looper commences to move to right

180° Under looper point ¼ in to left of straight needle, straight needle in lowest position

195° Cast-off wire forces the thread on to the circular portion of discs

210°. Under looper point enters between the straight needle and its thread

230°. Pull-off lever is in line with the two thread guides—the thread passing straight through all three parts

260° Overhead looper in lowest position

270° Small flat part on both take-up discs commences to draw the thread out of the straight line between the two thread guides

290°. Under looper at extreme right, small forked part of overhead looper enters between the under looper and its thread.

305°. Thread leaves small flat parts of take-up discs, and the latter are therefore inoperative.

360°. Under looper through loop of straight needle, and point of under looper $\frac{3}{16}$ in to right of straight needle and moving to right; overhead looper has brought thread from under looper over the edge of cloth, and point of overhead looper is $\frac{1}{16}$ in to right of straight needle, which is now in its highest position
35° to 80° Feed dog moving downwards and forwards
80° to 220° Feed dog moving forwards only
220° to 250° Feed dog moving upwards.
250° to 280° Feed dog moving upwards and backwards.
280° to 35°. Feed dog moving backwards and drawing cloth through
80° to 230°. Pull-off motion moving backwards
230° to 270° Pull-off lever, passing the back centre preparatory to pulling thread again for next length
270° to 80°. Pull-off lever commences to travel backwards, and thread being pulled off bobbin
100° to 195° Thread being taken up by take-up discs.
230° to 270° Thread passes straight through the two thread guides, being allowed to do so by small flat parts on the take-up discs.

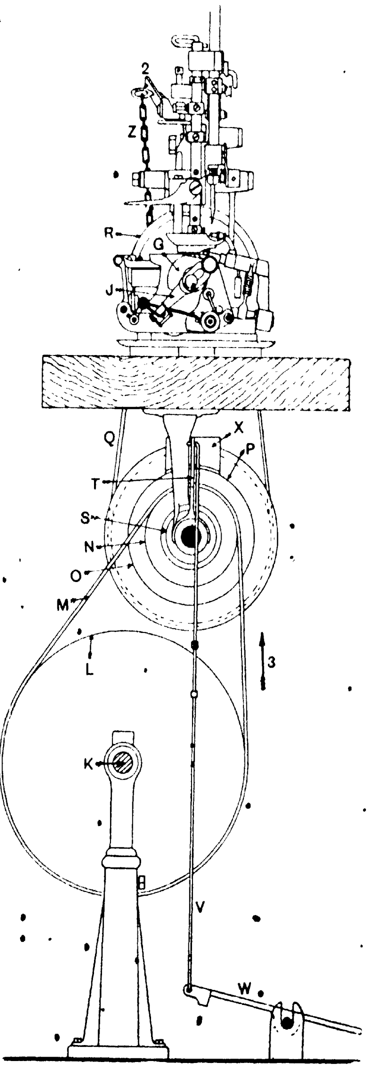


Fig. 161.

The driving arrangement is as follows:— Shaft K receives its motion from a main shaft or motor, and carries under each machine a pulley L. A belt M connects pulley L with pulley N, to which is secured the conical friction pulley O. This conical driver enters a corresponding internal cone in band disc P, while a leather band Q, shown only in Fig. 161, connects P with the hand-wheel R of the sewing-machine. It is necessary that disc P should be capable of being started and stopped at will, and this is done by means of a clutch S operated by the forks of lever T fulcrumed at U. The outer end of lever T is connected by adjustable wire rods V to treadle W, while the opposite end of U carries a projecting part X fitted with a leather pad which acts as a brake on disc P. It is clear that when the back part of treadle W is depressed, rods V and lever T will move downwards, brake X will be withdrawn from disc P, and clutch S will force driving cone O into close contact with disc P, which will rotate and therefore drive the machine. Immediately the pressure of the foot is withdrawn, the connection between the driving cones is broken by part O being forced to the

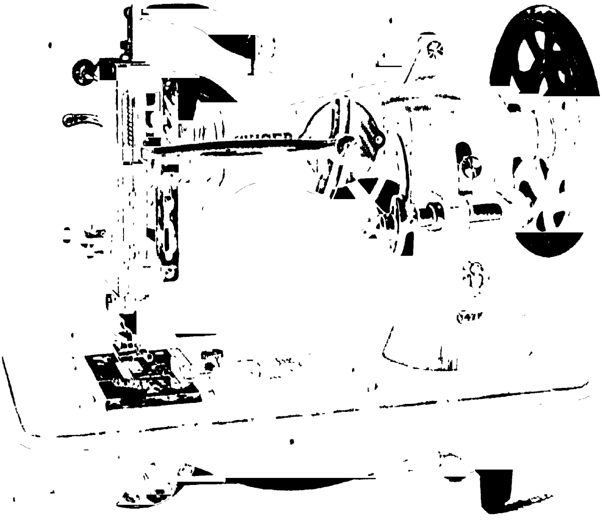


Fig. 162

left by means of an enclosed spring, and at the same time the brake X comes in contact with the disc P. The second treadle Y serves to lift the foot of the machine through chain Z and lever 2 The direction of motion is indicated by the arrow 3.

The whole of the driving arrangement of these machines is boxed in, so that there is little or no danger of accident to the operator. The machine itself is situated near the centre of the table, but is adjusted so that the top of the table is approximately level with the top part of the cover plates of the machine. These cover plates reach to the bottom of the "foot" or feeding part of the mechanism, and enclose almost the whole of the delicate machinery.

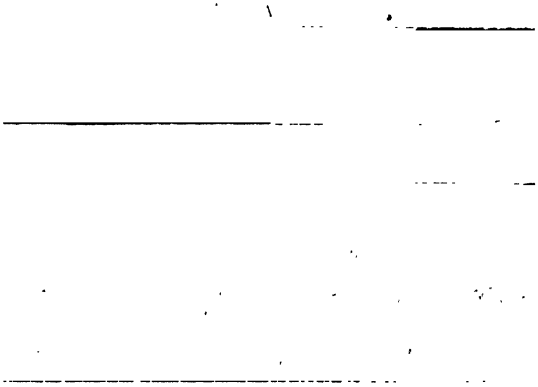


Fig 163

A new machine by Mr D. J. Macdonald, and termed the Simplex, makes the same stitch as the above but with fewer and more substantial parts. The mechanism, however, is quite different, and although the speed and type of sewing have been proved to be quite satisfactory, the parts of the machine are not sufficiently far advanced to allow of suitable illustrations.

Another machine by the Singer Manufacturing Co. and illustrated in Fig. 162 is used for somewhat similar purposes. The stitch is a zig-zag one as illustrated at B (Fig 163), but it is also capable of making straight stitches as illustrated at A if desired.

As already indicated, some of these machines compete with the overhead one for heavy work, but they may also be used to give the same style of sewing with lighter threads. The Yankee machine, on the other hand, is specially adapted for comparatively thin thread, and is used either as a hemmer or as a seamer. When used for hemming with a single thread the yarn may be used directly from a ball, from a conical cheese, from a bobbin, or from an ordinary cheese. In the two former cases the material rests on the table near the driving end of the machine, and the thread rises almost perpendicularly to the eye of an adjustable guide at a suitable height before being conveyed to the guides on the machine. When bobbins or ordinary parallel cheeses or rolls are used, however, it is essential that the whole of the yarn should rotate to give off the thread as it is demanded by the machine.

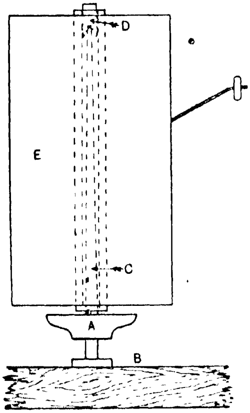


Fig 164.

A method of supporting the bobbins on the machine itself has already been illustrated in Figs. 127 and 128, *see* facing page 167, but since rolls or cheeses hold a much larger quantity of yarn than do bobbins, they are generally preferred. The rolls or cheeses are sometimes supported as illustrated in Fig. 164. A stand A is fixed to the table B, or else it is provided with a heavy base in order that it may be moved from place to place. When in work the stand is situated near the machine. An upright pin C, pointed at the top, supports the roll by means of a convenient form of cap D, the whole of the weight of the roll E is thus freely balanced and easy to turn, although the dimensions of the roll may be 8in. by 5in., or even greater, and is practically as high as the machine itself. Two rolls may be supported similarly when two threads are required, but the usual method in this case is to withdraw the threads from two balls which rest either on the table or on a double stand which is provided for the purpose.

left by means of an enclosed spring, and at the same time the brake X comes in contact with the disc P. The second treadle Y serves to lift the foot of the machine through chain Z and lever 2. The direction of motion is indicated by the arrow 3.

The whole of the driving arrangement of these machines is boxed in, so that there is little or no danger of accident to the operator. The machine itself is situated near the centre of the table, but is adjusted so that the top of the table is approximately level with the top part of the cover plates of the machine. These cover plates reach to the bottom of the "foot" or feeding part of the mechanism, and enclose almost the whole of the delicate machinery.

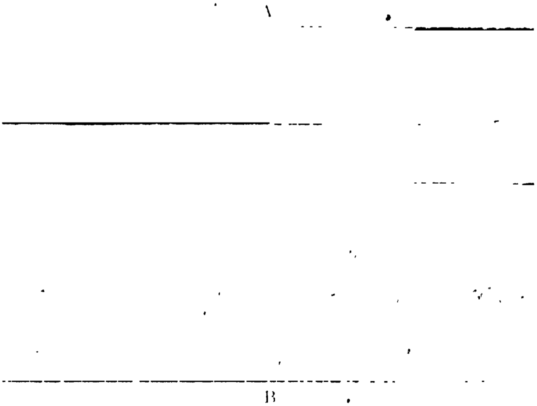
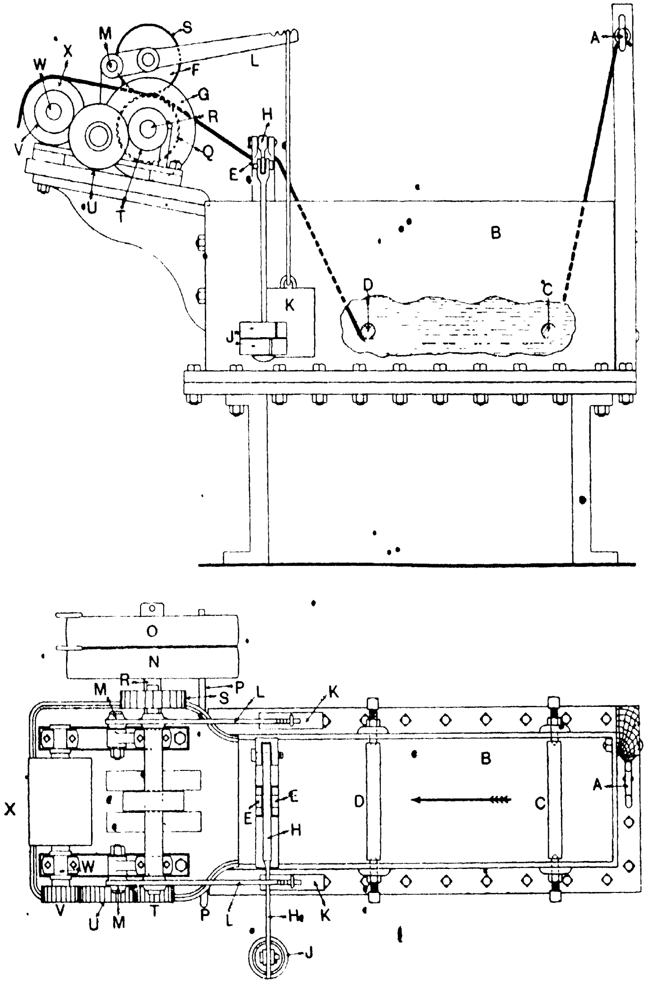


Fig. 163

A new machine by Mr D. J. Macdonald, and termed the Simplex, makes the same stitch as the above but with fewer and more substantial parts. The mechanism, however, is quite different, and although the speed and type of sewing have been proved to be quite satisfactory, the parts of the machine are not sufficiently far advanced to allow of suitable illustrations.

Another machine by the Singer Manufacturing Co. and illustrated in Fig. 162 is used for somewhat similar purposes. The stitch is a zig-zag one as illustrated at B (Fig 163), but it is also capable of making straight stitches as illustrated at A if desired.



Figs. 165 and 166

L, fulcrumed at M. The machine is placed in and out of action by the usual fast and loose pulleys N and O, and starting-rod P; a wheel Q on the main shaft R drives the roller G, while the roller F, which runs in a groove in roller G, is driven from Q by the wheel S. At the opposite end of the shaft R is a wheel T of 24 teeth, which, through the carrier wheel U of 37 teeth, drives a wheel V, also of 24 teeth, on the shaft W. This shaft supports and rotates the roller X, which carries the warp, or chain of linked hanks, forward as it is delivered by the rollers F and G. The main shaft of the machine is intended to make 48 revs. per min., which represents a speed of

$$\frac{48 \times 6\text{in.} \times 3.1416}{12\text{in. per foot}} = 75\text{ft. per min.},$$

but the actual speed will clearly depend upon several factors, such as the weight of the yarn, the consistency of the tar, and the desired degree of tarring. It is usual to use hot tar for the purpose, and to achieve this end the tanks are often provided with a jacket so that steam may be admitted between the tank and the jacket, and thus keep the tar at the proper temperature.

# CHAPTER XIII

## SACK AND BAG PRINTING

SACK PRINTING.—The majority of those who use bags or sacks for their produce or merchandise, and especially those who use large quantities, usually have some distinctive mark on the bags by means of which their goods and their property may be quickly recognised. A very common method, and one which is extensively practised, is that of introducing distinctive marks in the form of coloured threads in various parts of the warp. These threads form more or less prominent stripes in one or more striking colours, and, although the coloured threads are naturally more expensive than the grey threads which form the bulk of the warp, they involve little or no extra cost in the actual weaving. It is at once an economical and satisfactory method, provided that the coloured stripe or stripes are so arranged that they are unique in appearance. But in spite of the enormous number of different ways in which coloured threads may be arranged in the fabric, there is a sameness in many of the combinations, and there is nothing to prevent one or more persons using bags with stripes which are identical in width, number, position, and colours. Consequently, the most satisfactory method of imparting identification marks is that of having the name, trade mark, or other symbol of the firm or institution more or less permanently and prominently impressed upon the bag in colour. This is now, and has been for years, extensively done on special printing machines, and, in some cases, on machines which do not differ sensibly, except perhaps by weight, from similar machines which are used for ordinary printing and lithographic processes.

Although the heavy machine of the same type as is used for paper printing has undoubtedly a few important points in favour of its use for printing bags, still the bulk of sack printing is done on special machines, and Figs. 167 to 172 illustrate a well-known type as made by Mr T. C. Keay, Dundee. (Fig. 167 is an elevation

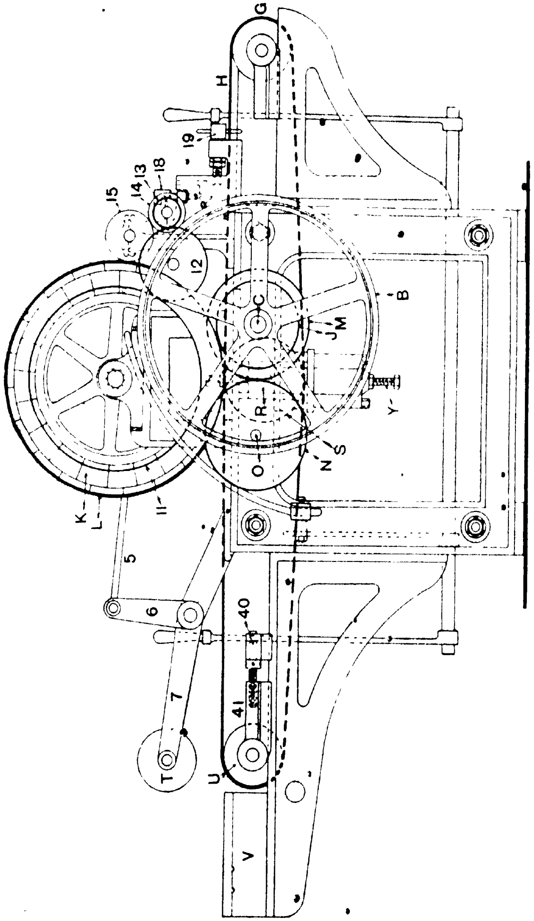


Fig 167.

of the driving side; Fig. 168 is a plan of the machine minus the set-on handles; Fig. 169 is an elevation of the side opposite to the driving, with one or two details; while Fig. 170 is an elevation of the delivery end of the machine, and also shows one or two details. The same parts in different views are marked by the same kind of letters. The machine under notice, which is termed a "single printer," or a one-colour machine, is placed in and out of action by fast and loose pulleys A and B, keyed and running loosely respectively on the main shaft C. This shaft passes through the machine, and at the opposite side carries a sprocket wheel D, which, by means of the chain E and a smaller sprocket wheel F, imparts motion to one of the rollers G of the feed sheet H. (In Figs. 168 and 170 the feed sheet is omitted.) Returning to the driving side of the machine, it will be seen that on the main shaft C is fixed a spur-wheel J which drives the printing drum K through the large spur-wheel L. Immediately behind the wheel J, and on the same shaft C, is fixed another wheel M, which gears with a wheel N of the same size and pitch, but fixed on the shaft O. This shaft passes right through the machine, and carries at the far side a spur pinion P, which gears with spur pinion Q of an equal number of teeth on shaft R. Shaft R carries the roller S, between which and the printing drum K the feed sheet H travels. It will thus be seen that the printing drum K is driven from the main shaft C by means of the wheels J and L, whereas the corresponding roller S is driven from the same shaft C by means of wheels M, N, P, and Q.

The surface speeds of the drum K and roller S are, of course, the same, for between these two travels the feed sheet H, while the article to be printed travels between the top side of the feed sheet and the drum K. The bags to be printed are inserted separately between the two rollers T and T¹, and the feed sheet roller U, and naturally when the two former are raised as indicated by the position of the front one T in Fig. 167. The bags are fed in by hand from the table V, and immediately the pressing rollers T and T¹ descend, the bag is drawn forward, and carried by the feed sheet H under the printing drum K. Printing drum K and roller S are kept in contact by a strong spiral spring W, which is enclosed in a suitable case; the strength of the spring can be regulated by means of the screw Y. If, therefore, any irregularity in thickness obtains in the bag, the spring W and roller S yield slightly, while for regular thicknesses the two parts K and S roll together without any vertical movement of the latter. Pressing rollers T and T¹, are raised and lowered by a cam Z on the shaft

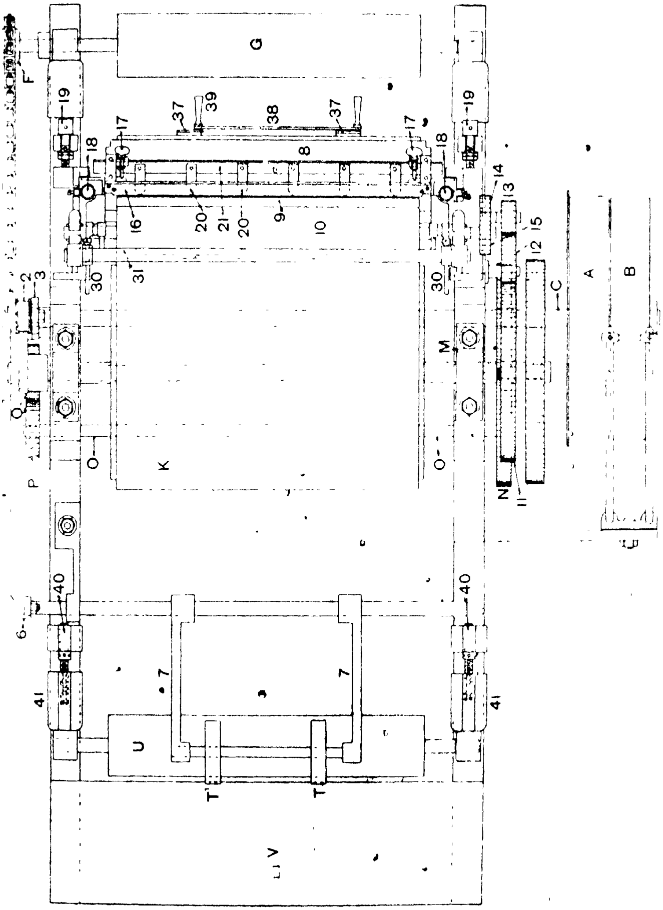


FIG. 168.

of the printing drum K. This cam operates on the grooved friction roller 2, which, through the lever 3 fulcrumed at 4, connecting-rod 5, and arms 6 and 7, imparts the desired motion at the proper time to the pressing rollers T and $T^1$. The cam may, of course, be adjusted to act at any desired point in the revolution of the printing drum K. The name, design, or trade mark to be printed is placed on the circumference of the printing drum K, the letters and designs being usually cut out from sheets of hard composite material such as elmite; at other times lead letters are moulded and used, and when these have served their purpose, the lead is melted and recast into other desirable forms. The composition letters are fixed to the cylinder by means of small tacks. It is of course essential that some kind of paint or colour should be supplied to the machine, and that this colour should be distributed evenly and regularly on the printing letters and designs. All the parts for supplying colour to the drum K are situated at the delivery end of the machine. The parts consist of colour box 8, colour roller 9, gelatine roller 10, and the parts which drive the two latter. They receive their motion from a large wheel 11 on the shaft of the printing drum K; this wheel 11 drives carrier wheel 12, which in turn rotates pinion 13 on colour roller shaft; wheel 14 is on the same shaft, and imparts motion to wheel 15 on the shaft of gelatine roller 10.

Colour roller 9 when in work is partially immersed in the colour in colour box 8; it draws up the colour and transfers it to the gelatine roller 10, from which it is removed as the letters or figures on printing drum K come in contact with it. The amount of colour can be regulated by means of a longitudinal colour supply knife or "doctor knife" 16, parallel to colour roller 9 and near to it when only a small quantity of colour is required; for larger quantities the doctor knife 16 is removed farther from the colour roller 9, and thumb-screws 17, one on each side, with satisfactory connections, provide means for making perfect adjustments. Pin-screw 18 is utilised for raising colour roller 9 into proper contact with gelatine roller 10; while screw 19 is for moving colour box, colour roller, and gelatine roller 10 so that the latter may be placed in its proper position with respect to the printing drum K.

In common with most textile fabrics it happens that small bits of fibre fly from the bags, and some of these settle on the colour roller, and so result in imperfect printing. In order to remove most if not all of these fibres from the roller, the machine is provided with a number of cleaner blades 20 (*see* Fig. 168) secured to the flat rod 21, all of which receive a slow to-and-fro movement as the machine runs. These blades 20 are set im-

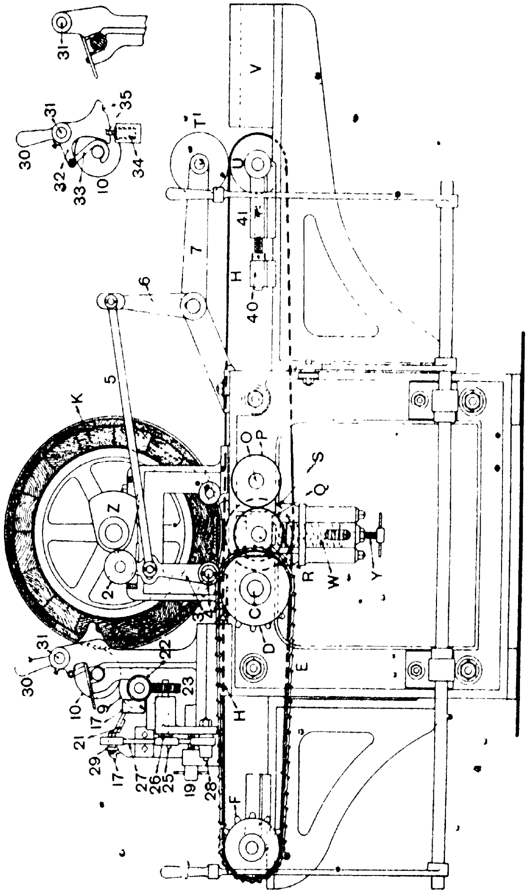


Fig. 169

mediately under the doctor knife 16, and in contact with the colour roller 9. Their to-and-fro movements enable them to remove the fluff, and so secure a proper and pure supply of colour-

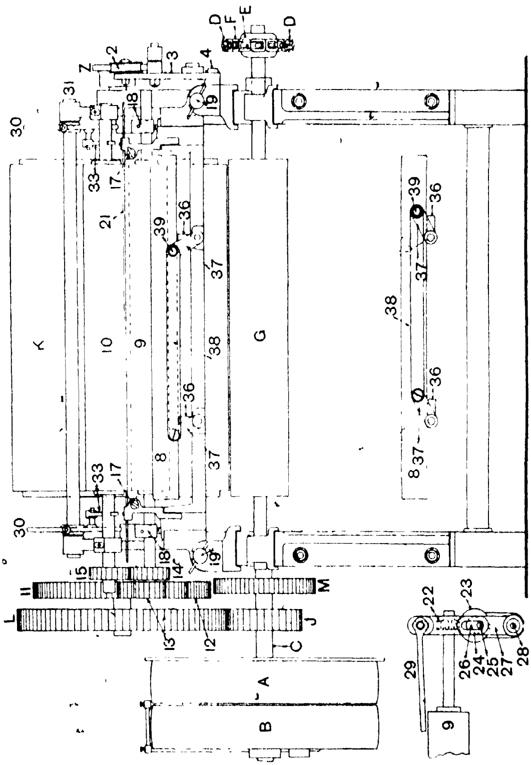
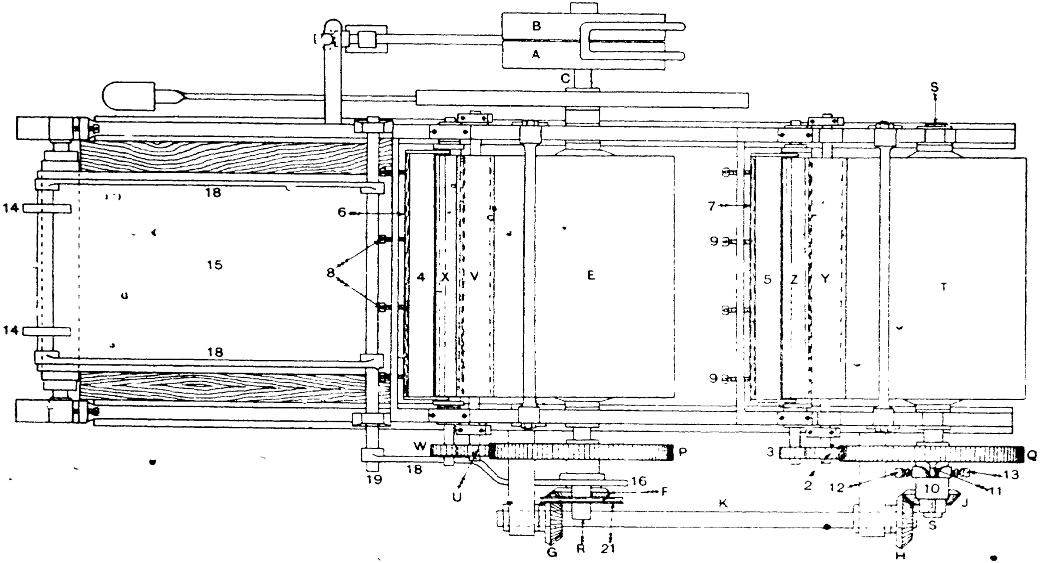


Fig. 170

ing matter. The knives 20 receive their motion from a worm 22 on the end of the colour roller shaft (see Fig. 169 and detached view in left-hand bottom corner in Fig. 170) ; this worm 22 rotates worm-wheel 23, which in turn rotates disc 24, near the periphery of which projects a pin 25. Pin 25 enters a slot 26 in lever 27, fulcrumed at 28. It is clear that lever 27 will oscillate slowly,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G
R
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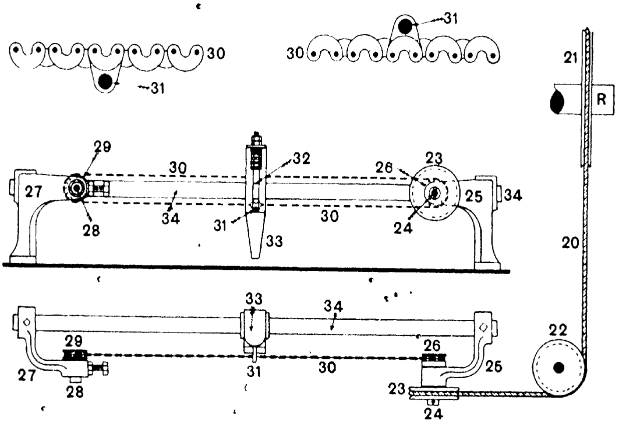
H

Fig 179.

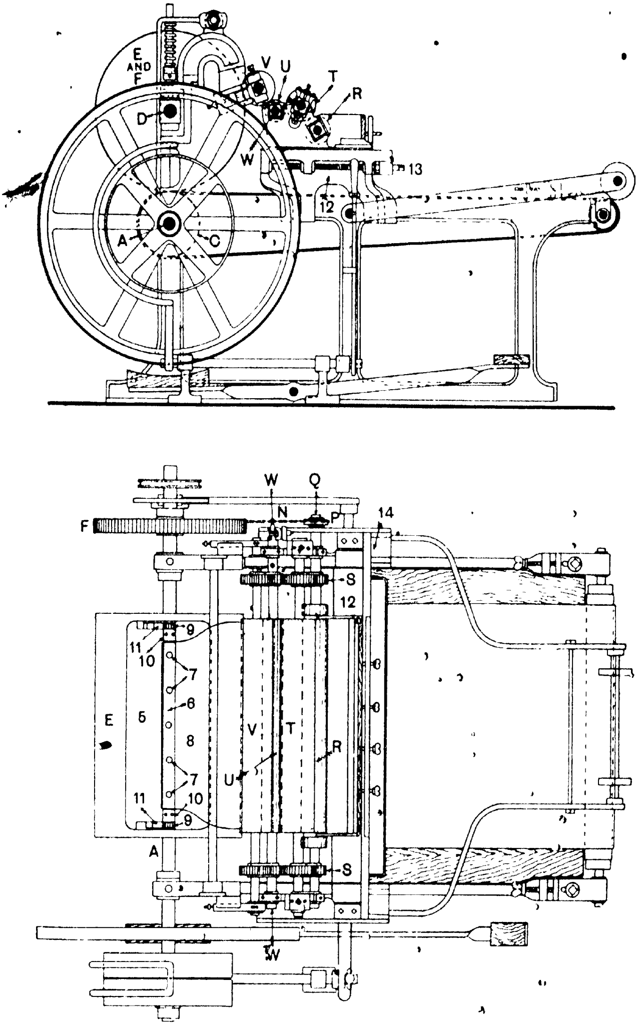
clockwise, while slackening screws 13 and screwing up screws 12 will turn the wheel Q clockwise—sufficient space being left between the slot in the clutch 10 and the projection 11 to admit of the necessary movement after the rough adjustment. The bags are fed in as already explained when the pressing rollers 14 are lifted from the cloth 15 by means of the cam 16, anti-friction roller 17, and lever 18 fulcrumed at 19; the cam and rollers occupy then the positions indicated in Fig. 184.

The mechanical stirrer illustrated in Figs. 180 and 181 is oper-



Figs. 180 and 181.

ated by means of a rope 20 from the grooved pulley 21 on the shaft R of the printing drum E (*see* also Fig. 179); a similar stirrer is driven from the shaft S of printing drum T. The rope 20 passes from pulley 21 to a guide pulley 22, then to pulley 23, and returns to a second guide pulley immediately below 23, and thence back to the pulley 21. The stud 24 of pulley 23 is supported by the bracket 25, and the stud also carries a chain pulley 26. A similar bracket 27 carries an adjustable stud 28, upon which rotates a second chain pulley 29. An endless chain 30 passes round the chain pulleys 26 and 29, and is thus kept in motion when the printing machine is running. The links of the chain 30 are shown on a much larger scale in the upper part of Fig. 180. A projecting part



Figs. 182 and 183.

on one of the links carries a pin 31, and the end of this pin enters the slot 32 of the stirrer 33. The pin 31 never leaves the slot 32, but serves to carry the stirrer to the right and left alternately. The lower end of the stirrer is immersed in the ink, and it occupies a position near to the base of the ink trough, and close to the periphery of the ink roller. It is evident that the stirrer will travel from one end of the trough to the other when the large link and pin 31 are moving say to the left, but as soon as the link reaches say the pulley 29 it will commence to pass round it, the pin 31 meantime sliding down near to the bottom of the slot 32. The further movement of the chain will thus enable the pin 31 to move the stirrer to the right: the stirrer thus moves forwards and backwards the full length of the trough on the shaft 34, and keeps the ink in the most satisfactory condition.

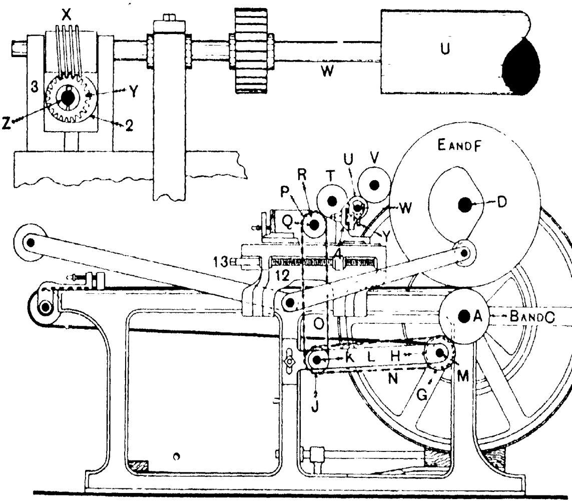
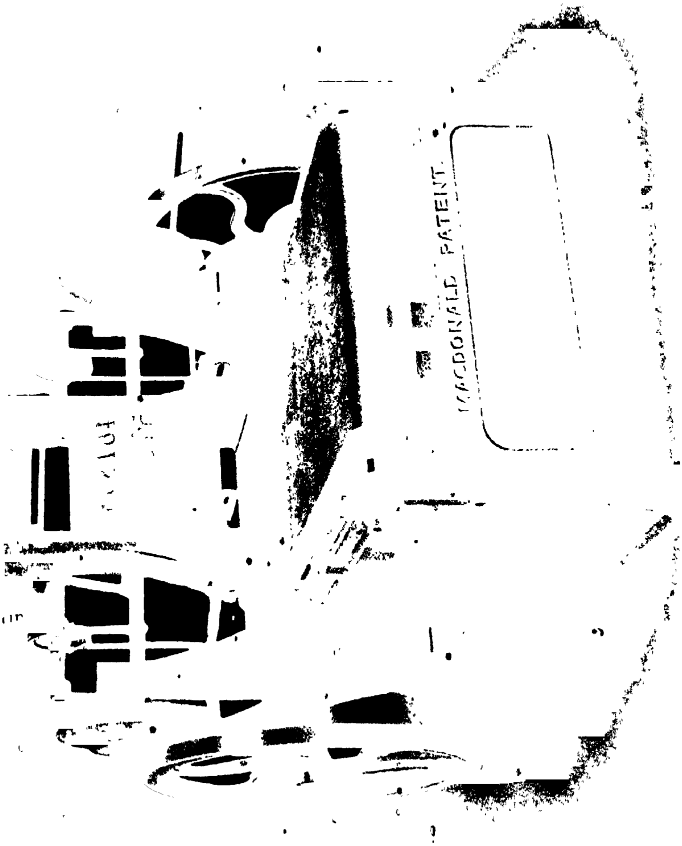


Fig. 184.

Figs. 182 to 184 show the latest improvements in connection with the sack printing machines made by Mr Macdonald, and although this machine is more expensive than the one just described, it contains a few important changes which are valuable for the better type of bags. Fig. 182 is a view of the driving side; Fig. 183 is a plan; while Fig. 184 represents the gear side and contains an enlarged view of the ink roller and its connections. One printing drum only is shown, but two, three, or more may be introduced into this machine, as in the others, if desired. The fast and loose pulleys, fly wheel, belt fork and handle, and the brake are clearly seen in Fig. 182. On the main shaft A is the usual wheel B of 33 teeth, and also the pressing roller C, the former drives the printing drum E on shaft D by means of the large wheel F of 94 teeth as before. A much steadier drive to the inking and gelatine rollers, however, is obtained as follows: The wheel B (Fig. 184), drives the wheel G, with which is compounded the sprocket wheel H. A similar sprocket wheel J on the stud K of the adjustable arm L, fulcrumed at M, is driven from sprocket wheel H by the chain N. A second chain O from the sprocket wheel J drives the sprocket wheel P on the shaft Q of the ink roller R. From the same shaft Q a wheel S of 29 teeth communicates the motion to a wheel of 36 teeth on the first gelatine roller T, while from this wheel is driven a wheel of 24 teeth on the brass distributing roller U, and finally the latter wheel drives another wheel of 36 teeth on the second gelatine roller V.

An end long movement of about half an inch is imparted to the brass roller U in order to distribute the ink evenly over the second gelatine roller V and therefore on the type. The mechanism by means of which this is effected is illustrated on a large scale in the detached view in the upper part of Fig. 184. The shaft W of the brass roller U is prolonged, and at its end is fixed a worm X. As the shaft revolves, the worm X moves slowly the worm wheel Y on the stud Z, and since the worm wheel Y and the cam 2 are compounded, it follows that the bracket 3 is caused to slide to and fro in the fixed bracket 4, and thus to give the desired lateral movement to the brass spreading roller U.

Instead of nailing the type on to the printing drum E, a novel arrangement is provided. The drum E in ordinary machines is covered with wooden staves, but in this case it is metal and a part of it is cut away, or rather left off in the moulding, at 5 (Fig. 183). A shaft 6 is made in two semi-circular halves, and these are set screwed together by screws 7 to grip between them a broad piece of linoleum 8, while the opposite end of the linoleum is fixed to a bar which in



turn is held by two hooked parts of the drum. The linoleum can thus be drawn perfectly tight on the drum by wheel 9 and screws 10, and held in this position by pawls 11. The type is nailed to the linoleum, and when once nailed is a fixture. Such a method is obviously intended for repeat orders, of which there are many: one piece of linoleum and the necessary type are required for each complete set.

In this machine the second gelatine roller is fixed in adjustable brackets in the frame, but the remaining three rollers, R, T, and U are supported by a movable table 12 operated by screwed rod 13. The table slides in guides 14.

When large quantities of bags are owned by individual firms, the method of printing provides a safe means of identification, but it does not take into account the number of bags in the possession of any firm, nor does it enable the owners to keep a record of the destination of certain bags. Mr. Macdonald's latest addition to the sack printing machine has been invented to eliminate this deficiency, and the machine is illustrated in Fig. 185. It is in reality a continuation of the printing machine, for it is fixed to the delivery end of the latter. Each bag which leaves the last printing drum is entered into the numbering machine, and its consecutive number printed on by the numbered discs shown clearly in the illustration. These printing discs are raised and lowered at the proper time in order, first, to allow the last numbered bag to be carried away, and another brought into position by the feed cloth, and, second, to imprint the consecutive number on the bag. Other suitable mechanism arrests the movement of the bag for a moment while the type is impressing the number on the bag. One-third of a revolution is occupied in raising the printing discs from the bag, one-third for dwell in the highest position, and one-third for lowering the discs on to the bag, all being of course imparted by a suitably shaped cam and ring roller which embraces the block.

The unit disc is intermittently moved number by number by means of a spring pawl which is hung on fixed pivots. As the discs descend, the pawl moves away from the discs, but as the latter is ascending, the pawl engages with a ratchet wheel, and rotates the unit disc through one division or number. Every revolution of the unit disc causes a projection on its face to move the tens disc one division, and so on with all the remaining discs.

The feed cloth is operated from the first printing machine by a suitable chain drive, but its forward motion is stopped intermittently and automatically for a moment when the bag reaches its position under the numbered discs.

The inking arrangement consists of the usual ink roller from which the ink is taken by a gelatine roller, the latter moves intermittently and horizontally below the ink roller and the printing discs, while the impressions are made in the usual way with a fixed rubber slab below the feed cloth.

Paraffin, turpentine, and similar liquids are used to thin down the paint or colour, and in all cases drip boxes are fitted so that the paint will not drop on to the bag which is being printed.

We have already mentioned that the bags are not so easily printed as paper, because of the elastic nature of the cloth, and because the two layers of the bag are inclined to move a little, one upon the other; hence, when two or more colours are used, some firms prefer to use the heavy type of ordinary printing machine, in which case the bag lies perfectly flat through all the machine, and, in consequence, the second or third colour is usually more accurately placed with respect to the previous printings in those cases where the two colours are in close juxtaposition, for ordinary cases, where the various colours are detached, satisfactory work is obtained from any of the machines.

## CHAPTER XIV

### STARCHING, DYEING, AND DRYING

APART from the simple operation of damping with water or with a light starch, preparatory to calendering or mangling, the operations and machines which have been described up to the present are conducted and employed respectively for what may be considered "dry-finishing." Although the dry-finishing process is used for the larger proportion of jute fabrics, and for a large quantity of flax, tow, and mixed fabrics, there is a considerable quantity of jute cloth which undergoes some process of dyeing or starching, or both, and enormous quantities of linen fabrics which are bleached to varying degrees of whiteness. This treatise is not intended to deal exhaustively with these processes, but since all these special finishing operations are so closely related, it is necessary at least briefly to refer to them all.

In many types of wearing apparel for ladies, gentlemen, and children, it is essential that some stiffening material, termed padding, should be inserted between the outer cloth and the lining in order that the garment may preserve its proper form. This material is invariably some kind of cloth. The most expensive ones are hair-cloth, cloth made of cotton warp and hair weft, and cloth composed of flax warp and wool weft. Most of these have usually sufficient elasticity without artificial additions, but nearly all other types of padding—*e.g.* flaxes, tows, tow and jute unions, and all jute fabrics which are intended for use as paddings--require stiffening, and sometimes dyeing, in order that they may fulfil satisfactorily the particular purposes for which they are intended. Both dyeing and starching or loading are conducted in practically the same type of machine—*i.e.* the jigger dyeing machine, one type of which is illustrated in front and end elevations in Figs. 186 and 187, and in plan in Fig. 188. The dyeing liquor or the loading starch is placed in the vat A, and is kept hot by means of steam which is allowed to enter when required through the valve B. A similar valve C is used for filling the vat with hot water, while valve D is the outlet. The cloth E is wound upon one or other of the rollers F and G, and is transferred from one roller to the other several times in order that the proper degree of colour or the correct amount of starch may be applied. In Fig. 186 it will be seen that the

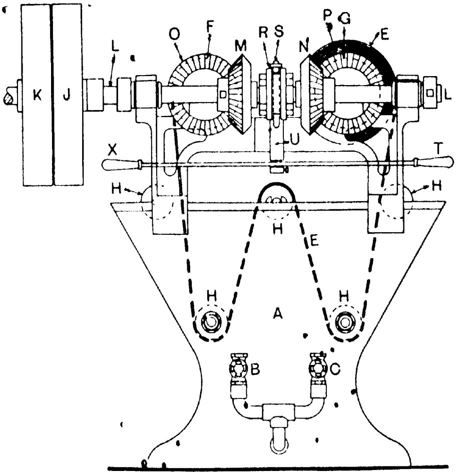
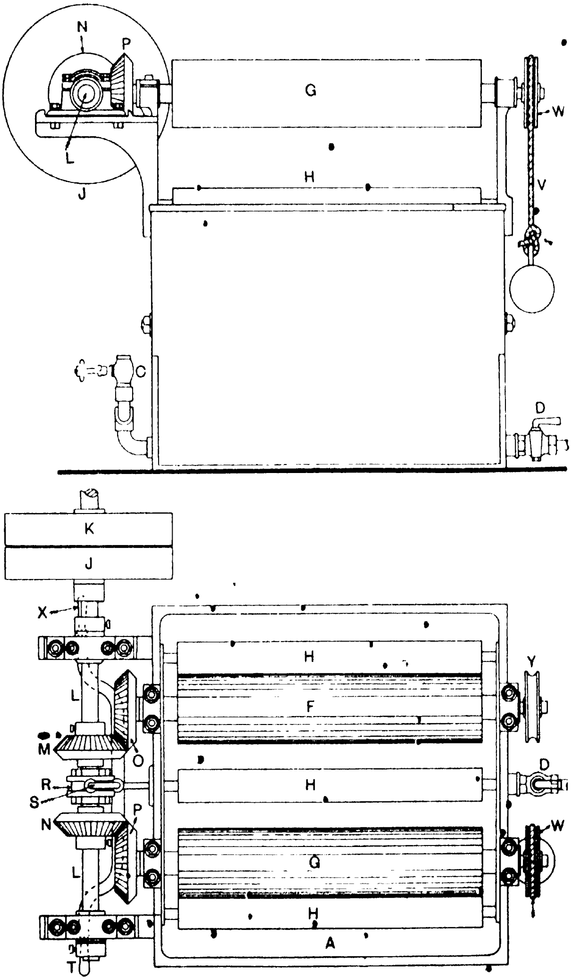


Fig. 186.

cloth passes from roller G under and over a series of guide rollers H before it reaches roller F—ropes or a short length of cloth being attached to each roller F and G and to the ends of the pieces which are to be treated. The jigger is put in and out of action by the ordinary fast and loose pulleys J and K on shaft L. Running loosely on this shaft are two bevel wheels M and N which gear respectively with bevel wheels O and P on the ends of rollers F and G. Clutch R rotates with shaft L, but is capable of being slid along the shaft in both directions by means of fork S. Thus, when handle T is moved outwards, upright rod U (Fig. 186,) is slightly oscillated, and the fork S places the clutch R in gear with bevel wheel M ; roller F will therefore be rotated, and will draw the cloth



Figs. 187 and 188.

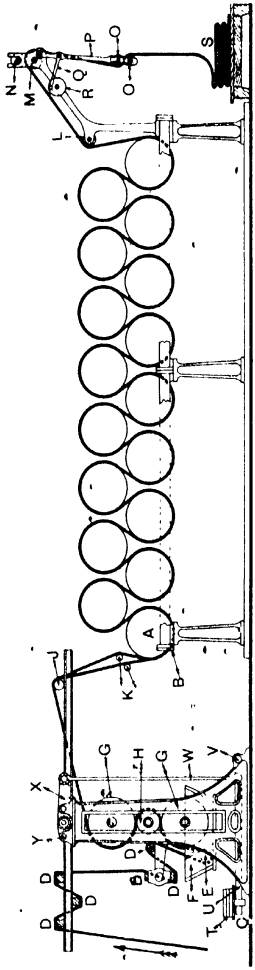


Fig. 189.

from roller G, which is free to run easily since the bevel wheel N is at this time clear of the clutch R. A weighted rope V passes partially round pulley W, and thus the roller is prevented from over-running while the piece is being unwound. Similarly, when the handle X of the same lever is moved outwards, the clutch R is placed in contact with the bevel wheel N, the weighted rope V placed over the drag pulley Y, and the piece wound off roller F and on to roller G. The above jigger is occasionally used for bleaching, but special bleaching apparatus is invariably employed when much work of this kind requires to be handled.

It is customary to use two separate jiggers for such goods as black paddings, one for the dye and the other for the starch, although it is not an uncommon practice to mix the dye and the starch, and to make one vat suffice for the combined processes. In any case, when the cloth leaves the jigger or the starch box it is necessary either to dry it partially or to dry it perfectly, and then redamp it slightly before submitting it to the glazing or other final finishing process. When the starching and drying processes are performed simultaneously, and if one run through the solution is sufficient, a combined starching and drying range is used somewhat similar to that illustrated in Fig. 189. This is what is termed the horizontal drying machine, and although it occupies more floor space than that occupied by the vertical type to be illustrated presently, it is considered by many to be the better of the two on account of the comparative ease with which the work can be performed; for low rooms the horizontal machine is the only feasible type.

The cylinders A, 17 of which are shown in Fig. 189, are usually made of copper, but sometimes of tinned iron, are about 22½in. in diameter, and all are supplied with steam, which enters through a steam supply valve near the end of the steampipe B. The ends only of the lower set of steampipes are shown in full, but a similar set is utilised for the upper tier of cylinders. Each cylinder is provided with an air valve, so that during condensation the air may enter and thus prevent any collapse. The condensed steam is withdrawn in the usual way. All rollers in the mangle, as well as the cylinders in the drying machine, are wide enough to accommodate two narrow pieces side by side at the same time—a common width being 66in., which is quite wide enough for two 28in. pieces to pass over abreast; wider machines are made when requirements demand them. The two pieces may be brought in rolls or in a loosely folded condition and placed on the stillage at or about C; they are then passed over and under tension rails D, passed round roller E in starch box F, between the two 22in. sycamore bowls G and the 9in. brass bowl H, over roller J, in front of conical opening rollers K, and then over all the copper cylinders A. The cloths emerge

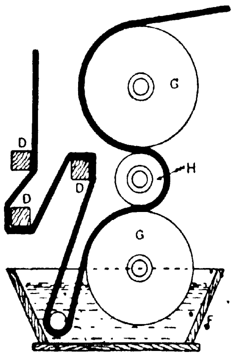


Fig. 190.

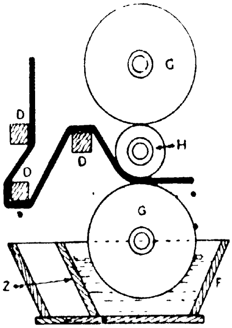


Fig. 191

at the opposite end usually perfectly dry, are carried over a guide roller L, between drawing and pressing rollers M and N, and finally between the plaiting or folding rollers O. These latter rollers are made to oscillate at the end of support P, which receives its to-and-fro motion from the short arm Q and a pin near the periphery of disc R. This folding, cuttling, or faking motion arranges the cloth in folds as illustrated at S.

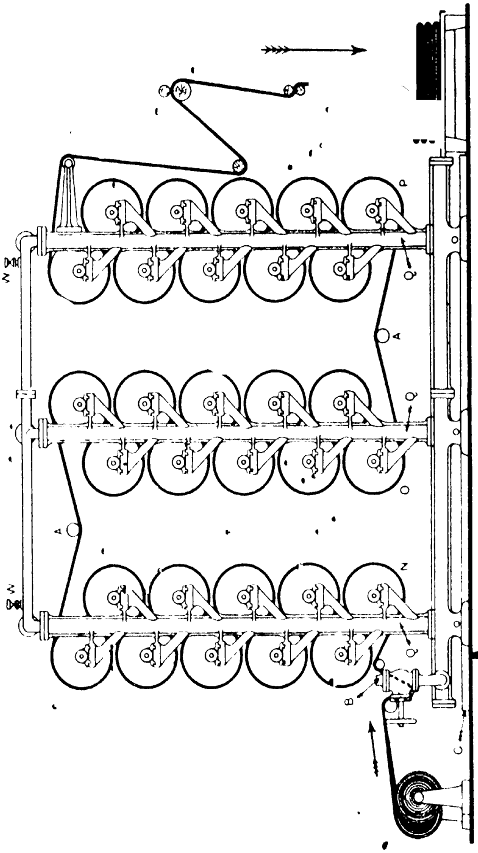


Fig. 192.

It will be seen that in Fig. 189 the cloth is immersed in the starch, so that both sides get treated. The superfluous starch is squeezed out between the bottom roller G and the middle roller H.

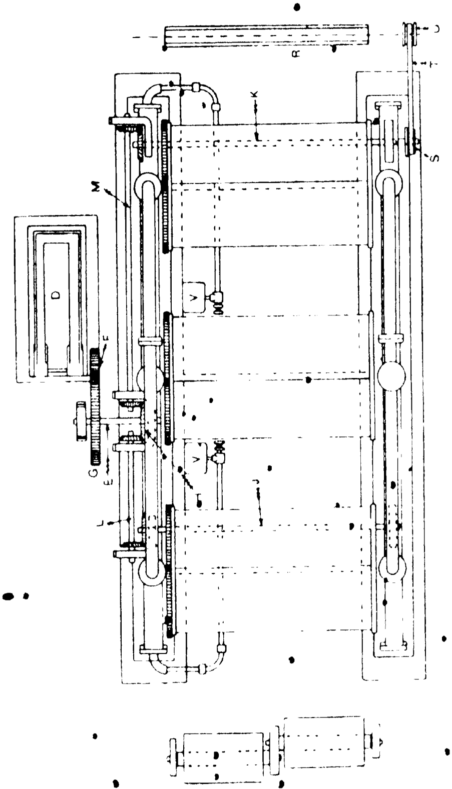


Fig. 193

The necessary pressure is obtained by weights T on the end of lever U fulcrumed at V, rod W and lever X fulcrumed at Y—the force being in the vertical plane which passes through the centres of the bowls or rollers. Occasionally one side only of the cloth requires to be starched, in which case a different method of threading the cloth is necessary. Figs. 190 and 191 illustrate the provision which is made for treating both cases. Fig. 190 is identical with, but on a larger scale than, the similar parts in Fig. 189, but in Fig. 191 the cloth passes direct between the two lower rollers G and H, and receives starch only on the underside, the starch being carried up by roller G. The wooden cistern or box F is made with a removable board Z; this board is withdrawn when both sides of the cloth are being starched as illustrated in Figs. 189 and 190, but is replaced when starching one side only as in Fig. 191, and thus necessitates a smaller quantity of starch.

When the jigger is used, the pieces are often removed from the rollers and folded loosely into cage barrows, and when this method is adopted the three-bowl starch mangle shown in Fig. 189 is not required. The barrow is wheeled immediately behind the first cylinder A, and the two pieces may then be passed over a roller similar to J and then over the cylinders, or the machine may be arranged so that the upper tier contains one more cylinder than the lower tier, in which case the cloths pass directly from the barrow over the first upper cylinder, and drop into a similar barrow placed under the last upper cylinder—in other words, the cylinders as illustrated in Fig. 189 are inverted. Some jiggers are provided with an extra loose roller, so that when the piece is passing through the solution for the last time it may be wound on to this special loose roller, and the whole—roller and piece—carted to the back of the drying machine. In some cases the reversal of the direction of the piece from one roller to another is performed automatically.

A similar three-bowl mangle may naturally be used in conjunction with the vertical drying machine, but it is unnecessary to introduce the mangle again; we, however, illustrate the vertical drying machine in Figs. 192 and 193, which show respectively a side elevation and a plan. More details are introduced into this drawing, but somewhat similar parts are used in the horizontal machine. The illustrations show that two pieces on rollers are placed side by side in standards, passed over and under guide rollers and patent expanders, not shown, and are then threaded over the cylinders as indicated by the heavy black line. Three pairs of uprights Q support 30 cylinders, but more are often used, and, in consequence of the difference in length which obtains between the pieces in the different stages of dryness, it is necessary to introduce tension rollers at A to take up any slack which may have a tendency to collect and thus hinder perfect work. It will be understood that there may be several pieces on one roll, but in all cases the cloth follows the same path, which is clearly indicated in the figure.

Steam enters at B, and passes through all the steam pipes, the vertical ones of which are uniquely arranged as supports for the cylinders themselves. A steam gauge is also provided to register the pressure, which is usually about 15lb. per sq. in., while the whole machine stands in cast-iron troughs C. The method of driving the cylinders is illustrated in Fig. 193. A small steam engine is situated at D, and drives the main shaft E through pinion F and wheel G. A bevel wheel H on the main shaft E drives the other shafts J and K through similar bevel wheels and side shafts L and M. Spur-wheels on shafts E, J, and K gear with toothed wheels on the ends of the lower cylinders, N, O, and P (Fig. 192). Each cylinder is provided with a similar wheel by means of which it is driven by the wheel on the end of the cylinder immediately below and on the opposite side of the upright Q. A continuous positive drive is thus imparted to every cylinder. The plaiter or

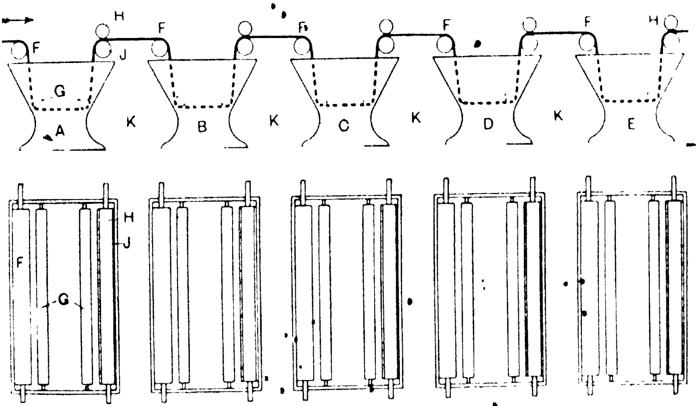


Fig 194

folder R is driven from a pulley S on the end of shaft K by belt T and pulley U. The necessary steam traps and air valves are supplied at V and W respectively.

As already mentioned, the operations of dyeing, starching, and drying are in many, if not in most, instances performed independently of each other, and the pieces are conveyed from one machine to another in succession. In other cases the dyeing is a separate operation, and the starching and drying are combined as in Fig. 189, while in a few cases the three processes are performed simultaneously, so that the grey piece enters at one end, and leaves at the other end in the form of a dyed, starched, and dried fabric. When the latter method is employed, the path which the piece follows is somewhat similar to that which obtains in the chroming vats used for cotton goods, and in continuous dyeing machines where in both cases multiple vats are used.

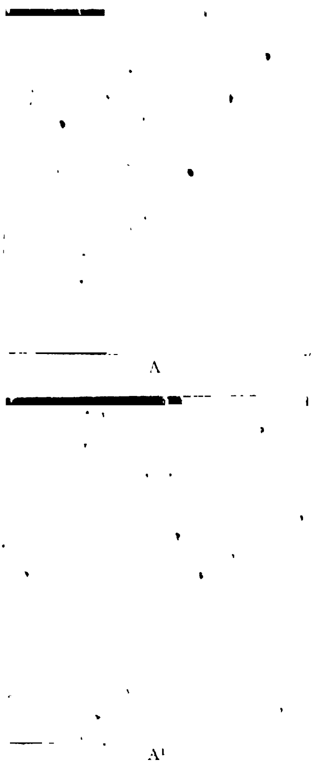


Fig. 195.

Fig. 194 illustrates, in a more or less diagrammatic fashion, a plan and elevation of the dyeing and starching apparatus of such a continuous range; the cloth, which is brought to the machine either in a loose form or on a roller, is placed immediately on the left of the first vat A, and after traversing through the liquids in vats B, C, D, and E, is taken over a set of drying cans or cylinders such as are illustrated in Figs. 189, 192, and 193. The vats shown are identical with the jigger illustrated in Fig. 186, but simple wooden vats serve the same purpose. The pieces often run two abreast, and first pass over guide roller F (Fig. 194), under rollers G near the bottom of the vat, and then between pressing or squeezing rollers H and J; a similar group of rollers is provided for each vat. The heavy line represents the cloth, and shows that the cloth passes directly from the pressing rollers of one vat to the guide roller of the next vat. This arrangement is feasible when the cloth may be drawn forward without injury through all the vats by the last pair of rollers, in which case the vats may be situated close to each other. If, however, it is necessary that each pair of rollers should not only press, but also draw forward the cloth, or that two sets of rollers should be employed for the two purposes, it is usual to leave a gap between the vats as illustrated, and to make provision for part of the cloth to collect between each pair of vats; in this way the various vats are independent of each other, and thus provision is made for any alteration in lengths due to the action of the different liquids. Under such conditions the cloth may fall on to a stillage, or on to slowly travelling endless cloths placed between each pair of vats, and at a height indicated by K. Another method is to introduce compensating rollers between each pair of vats.

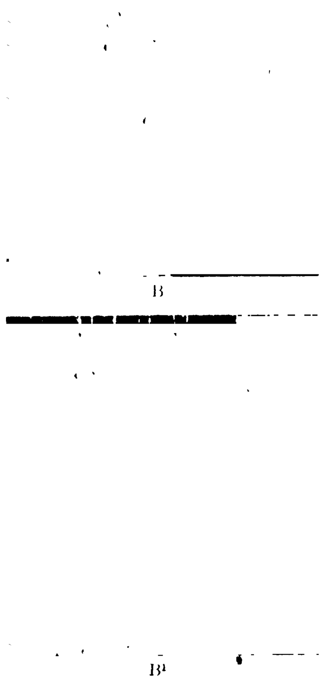


Fig. 196.

Cloth which is intended for paddings may be required either a brownish colour or black, in addition to being starched and glazed; both types of finish, with the exception of glazing, can be produced in the same machine. The great advantage which attends the use of apparatus similar to that illustrated in Fig. 194 is that the work is continuous, and in consequence there is less handling of the pieces.

The usual method of dyeing blacks for paddings is to run the cloth through one or more vats, or once or twice through the same vat, containing a solution of logwood extract or Hematine crystals, bark extract (quercitron bark), soda ash, and turmeric or fustic. It is then passed through a bath containing copperas. The dyed cloth is then ready to be starched. In the continuous range such as is illustrated in Fig. 194, the vats A, B, and C contain the first solution; vat D contains the copperas, when black is desired: while vat E is reserved for the starch. Flour, sago, tapioca, maize, white and grey farina, and dextrine or British gum, are used in various quantities as the adhesive substance, according to the colour of the cloth and to the amount of loading desired, while china-clay and black clay are used as special loading agents.

The solution in the first three vats shown in Fig. 194 stains the cloth to a brownish-purple colour, and the copperas then turns it black. It is a common practice to use fustic in the dyeing, because it brightens the cloth; if this substance is omitted, the cloth is usually dull and possesses a bluish cast. After the cloth leaves the copperas bath it passes through the starch box E, then between the last pair of squeezing rollers, and is finally guided on to the first can or cylinder of the drying apparatus.

When the starching is done independently of the dyeing, the cloth is often run through the starch box two or more times, depending, of course, upon the degree of stiffness required. The starch paste may also be made of any desired thickness, and when the operation is continuous—*i.e.* when the cloth is run through only once—it is evident that the thickness of the starch paste may vary from time to time for different classes of goods and for different degrees of loading. The amount of starch of a given consistency which a cloth will absorb may be varied, however, by altering the weights on the pressure rollers H (Fig. 194); and this is often done in continuous starching ranges to obviate the necessity for making starches of different thicknesses. The prepared starch may be introduced into the vat by small vessels, or a pipe, provided with a valve, may be arranged to conduct the starch directly from the boiling and mixing tanks to the starch box as desired. The latter is obviously the cleaner method, and ultimately the more economical.

The starching is light, medium, or heavy, according to requirements, and may add anything up to 50 per cent., or even more, of the weight of the piece. Common proportions of combined substances vary from ½ to 3lb. for each gallon of water. The mixture, which may contain the flour of two or three kinds of cereals, as well as a loading agent and the necessary amount of water, is boiled in the usual manner.

Figs. 195 and 196 are photographical reproductions of four small samples of jute hessians which have been woven and dyed in the Dundeee Technical College specially for the purpose of illustrating this branch. The quantities of dyewares used are as follows:—

### FIRST BATH.

| | Per cent. of Weight of Sample. |
|---|---|
| Hematine crystals (hæmatein = a product of logwood) | 15 |
| Soda ash, $Na_2CO_3$ | 2 |
| Bark extract (quercitron bark) | 2 |
| Turmeric | 2 |

### SECOND BATH.

| | |
|---|---|
| Copperas (green vitriol) Ferrous Sulphate $FeSO_4$ | 15 |

Patterns A and A¹ (Fig. 195) are cut from a hessian cloth made from the ordinary kinds and qualities of warp and weft. Patterns B and B¹ (Fig. 196) are cut from a hessian cloth made from the same warp as above, but woven with Daisee weft. A and B show the effects in the two samples after they had been treated with No. 1 bath, while A¹ and B¹ show the effects which result after having passed the dyed samples through the copperas or No. 2 bath. It will be noticed that, although the weft in pattern B is much darker than that in pattern A, the corresponding dyed sample B¹ is not nearly so black as pattern A¹.

It will, of course, be understood that the dye liquor in which the above patterns were dyed was not exhausted, and a smaller percentage of dyewares would be sufficient where the dyeing was more or less continuous. The quantity of dyewares would also be influenced by the depth of colour desired, for some so-called blacks are little deeper than dark greys. When the cloth leaves the drying cans or cylinders it is allowed to lie, if possible, several hours before being damped preparatory to the process of calendering. The cloth may then be run two or three times through a glazing calender if a high finish is desired, but if a dull finish is desired it is run through the ordinary calender once on each side of the cloth.

# CHAPTER XV

## WATERPROOFING

WATERPROOFING.—The machines and the processes illustrated and described up to the present embrace, if not all, at least the most important of those which are in everyday use for the finishing of heavy goods made from long vegetable fibres. The most important omission is, perhaps, that branch which deals with the waterproofing of heavy fabrics. Although this branch has been in operation for many years, it may be considered as one of the latest developments of the trade, and the processes followed, as well as the proportions of the various ingredients used for obtaining the necessary degree of impermeability to atmospheric influences, are in general, and naturally so, kept secret by the various firms who engage in this important industry.

Certain types of cotton and flax canvas and duck cloths are so well made, and so closely and heavily woven, that they are comparatively proof against rain so long as the cloth remains suspended —*e.g.* in the form of marquees and tents ; but immediately it comes into contact with any solid substance, the moisture passes through. Under ordinary circumstances it is unnecessary to do anything to these types of cloth other than to see that they are carefully woven and finished ; but for special purposes it may be necessary to add some kind of waterproof substance to the fabric, and it is the addition of these substances which gives rise to the term of waterproofing.

There are two general methods of waterproofing : (1) That by which the fabric is coated with a film of some substance which is proof against wet ; and (2) that by which the numerous small openings in the cloth, as well as those in the yarns from which the cloth is made, are filled with some such substance. Solutions of paraffin wax and ceresine in benzene or petroleum benzene, ammoniacal solutions of various metals, and various sulphates and chromates of metal, are used, the most common substances used are, perhaps, aluminium acetate, ammonium cuprate, and pitch or tar.

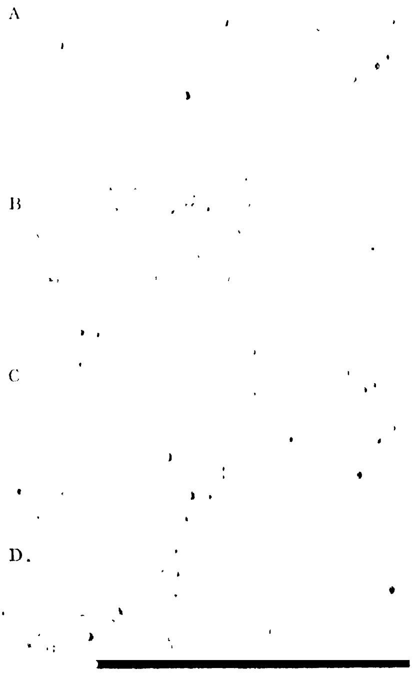


Fig. 197.

When the waterproofing substance is in solution the operation may be conducted in a jigger similar to that illustrated in Figs. 186 to 188, pp. 230 to 231, and the necessary degree of impregnation obtained by running the cloth forwards and backwards several times. Solutions are usually the best because the liquid penetrates the fibres and also fills up the interstices of the cloth. After the cloth has been thoroughly impregnated with, say, aluminium acetate, it is dried, and basic aluminium acetate is formed and deposited in the interstices of the fabric. Ammoniacal copper oxide exerts a solvent action on cellulose, and when the ammonia is volatilised by means of a current of air, the cellulose, as well as copper oxide, is precipitated in the interstices of the cloth. In all cases the solvent is removed by drying, and the precipitated substance adheres to the fabric.

Solid purified hydrocarbons, such as paraffin wax and the like, may be used, in which case the solid substance is often applied at the calender, where it is pressed against the steam-heated cylinder, or else rubbed on a roller which is pressed hard against the hot cylinder. In both cases the solid substance is deposited on the surface of the fabric in the form of a film.

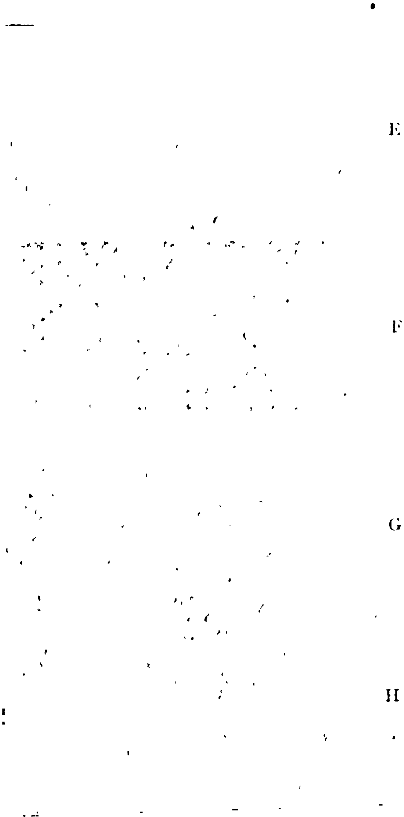


Fig. 198.

Pitch is applied hot by pouring it over the cloth, and then spreading it carefully by hand with a long hard brush. One or two fixed brushes may be used, and the brushing, or rather the spreading, may be done mechanically as the cloth passes slowly under them. According to another method, the pitch is deposited on the full width of the slowly moving fabric through a narrow adjustable slot in the bottom of the tank which holds the tar; then the cloth is passed between rollers, and finally under the fixed brushes. The rollers squeeze part of the tar into the heart of the fabric, and the surface tar is spread evenly over the fabric. If necessary the bottom roller may rotate in hot tar, in which case the latter is applied on both sides of the fabric, and a more perfect impregnation results. The cloths are dried, according to treatment, on hot cylinders or cans, or on rods in rooms specially heated and adapted for the purpose.

Figs. 197 and 198 show a range of fabrics which have undergone some type of waterproofing or heavy filling.

A = flax canvas, greenproofed and rotproofed.
B = cotton canvas, greenproofed.
C = jute tarpaulin, greenproofed.
D = flax canvas, whiteproofed.
E = flax canvas, blackproofed.
F = jute tarpaulin, waxproofed.
G, H = jute cloths for hats, heavily glued and starched.

# CHAPTER XVI

## BLEACHING

**Bleaching.**—Although many of the actual finishing processes and the machines in which the various operations are conducted for fine linen goods are very similar to those in use for the heavier class of goods, there are many intermediate processes essential for the successful treatment of these fine linen fabrics—processes which are quite unnecessary for those fabrics which are delivered and used in what may be correctly called their natural colour. For instance, large quantities of fine and medium linen cloths are dyed in all colours and then finished according to requirements, to be used ultimately in the manufacture of dresses, blouses, shirts, curtains, blinds, and the like. The addition of colouring matter to fabrics naturally belongs to the subject of dyeing, and forms no part of this treatise. Again, most of the finer linens are subjected to a more or less extended process of bleaching, and, although this process is in reality a particular and separate branch of the textile industry, it is usually considered as a concomitant part of the finishing process, and as such must at least be considered even if, as in this case, it cannot be treated exhaustively. Many cloths intended for dyeing, particularly in pale colours, must first be bleached.

The bleaching of linen is a much more difficult problem than the bleaching of cotton, for while cotton is almost pure cellulose, linen contains a comparatively large percentage of impurities, in particular pectic acid, and these impurities being more or less intimately mixed with the cellulose, are difficult to remove.

Practically the same or similar operations are necessary no matter what degree of whiteness of the fabric is desired, for it is simply a question of repeating the cycle of operations once, twice, or three times in order to attain the stages known technically as half-bleach, three-quarter-bleach, and full-bleach, or their practical equivalents—duck, house duck, and high house duck (D., H.D., and H.H.D.). The operations involved, without reference to the exact order, or to the number of repetitions of any one of them, are: Marking, sewing, singeing (seldom for linen), steeping, washing, squeezing, liming, boiling, souring, exposing in fields, rubbing, reeling or scutching, and chemicking; in addition to these, there are the actual finishing operations through which the fabrics afterwards pass, according to the desired finish.

Fig. 199 is a plan of a small bleach-house for linen goods, and, although the cloths do not pass from one end to the other of a long shed, the machines are situated in what are considered suitable places for carrying out efficiently the above operations without unduly travelling over the same ground.

A = lodge.
B = yard.
C = direction to power-house and boilers.
D = grey-room.
E = entering table.
F = singeing room.
G = drug store.
H = grey pile.
J = saturating machine.
K = kier wagon.
L = rails for running wagon into kier.
M = boiling kier (low pressure).
N = pump for hot water.
O = engine for low-pressure kier.
P = washing machine.
Q = high-pressure vertical kier.
R = heater.
S = pump.
T = wash mill.
U = rubbing boards.
V = chemick caves or kieves.
W = chemick pump.
X = sour caves or kieves.
Y = sour pump.
Z = opening winch or scutcher and plaiter.

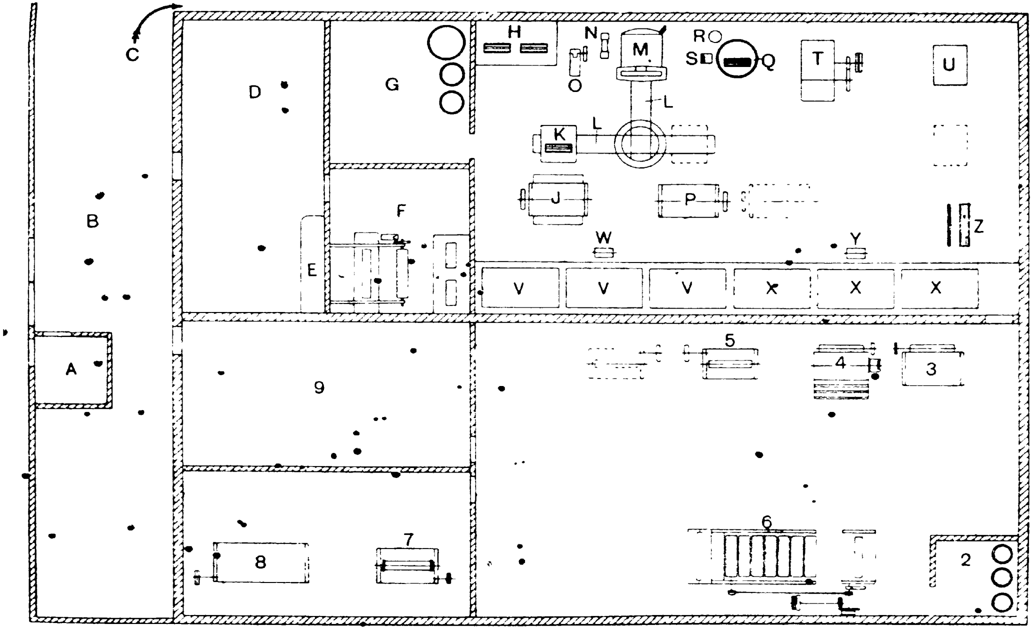


Fig. 199.

2 = starch mixing room.
3 = belt-stretching machine.
4 = spray damping machine.
5 = three-bowl finishing calender.
6 = starching and drying range.
7 = patent spring hammer beetle.
8 = wood faller beetle.
9 = making-up room, warehouse and offices.

The dotted spaces indicate positions for other machines similar to P, U, and 5 respectively.

When the linen goods in the form of grey cloth arrive at the bleachworks, they are first examined, and, if not wanted immediately, are stored in the grey-room. In general, however, they are delivered to the bleacher for immediate treatment. Since it is necessary to be able to distinguish between the goods from various manufacturers, and also between the different varieties of goods from the same manufacturer, and since the bleaching process is calculated to remove all ordinary colouring matter, it is essential that all pieces should be marked with some kind of indelible ink, or else with Turkey-red or other fast-dyed cotton thread. When the marking is done with cotton, the name, initials, or number of the manufacturer, as well as other particulars, such as the date, the degree of whiteness required, etc., are sewn in either by hand or by means of a special sewing or numbering machine. The loom number, quality number, etc., are naturally sewn in at the manufacturer's. If, instead of sewing in the necessary particulars at the bleachworks, similar particulars are written or stamped at the end of each piece with indelible ink, the latter is allowed to dry perfectly before the pieces are immersed in any liquid, so as to remove all danger of the ink spreading or staining other parts of the fabric.

Several of the marked pieces are then sewn end to end by sewing machines made for the purpose, and the pieces thus form a chain which greatly facilitates the handling in the various processes. This sewing is done in the grey-room, which is invariably separated from the remainder of the bleachhouse. In many cases the combined length of the sewed pieces is a few miles, and the chain may weigh two tons or even more. The chain being complete, one end is passed through a wooden or porcelain guide, and, if necessary, over rollers fixed in convenient positions to guide the chain from the sewing or grey-room to the first machine. Originally it was a common practice in the first stage to steep this chain of pieces in spent lye so that all dirt, dust, dressing, and other loosely attached foreign matter could be removed; but this process, although not yet entirely discarded, is seldom practised for linen goods. If, however, such a process, which is often termed the rot steep, is deemed desirable, the chain is first deposited into a large tank partially filled with spent lye. In some cases hot water is used for steeping. As already stated above, this process is often omitted, in which case the chain passes from the grey-room direct to the liming machine, which is illustrated in sectional elevation and plan in Figs. 200 and 201. Slaked lime, $Ca(OH)_2$, is added to water to

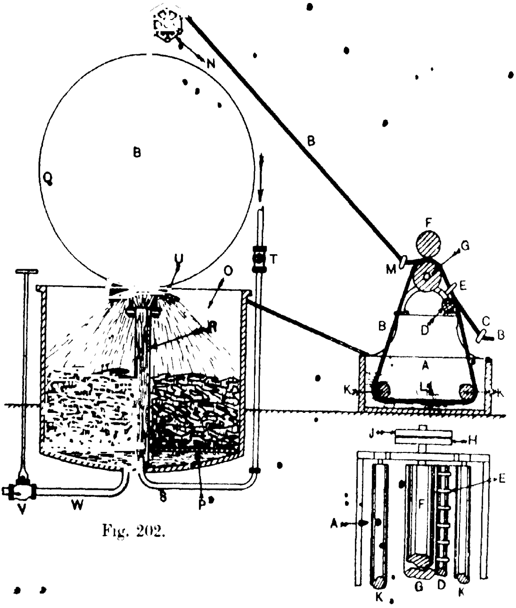


Fig. 202.

Figs 200 and 201.

form a thin milk of lime, and this liquid is introduced into the tank A either by pipe and valve, or by suitable vessels. Before the liquid enters the liming machine it is made to pass through a sieve in order that all unbroken lumps of $Ca(OH)_2$ may be arrested, and thus the substance is prevented from coming into direct contact with the cloth. Sometimes the slaked lime is enclosed in a perforated vessel and immersed in the water for the same reason.

The chain of pieces B, after leaving the grey-room, is first passed through a conveniently situated porcelain guide C, over the anti-friction roller D, between the first pair of pegs E, and then led between the top and bottom rollers F and G. The latter is placed in and out of action by fast and loose pulleys H and J, while the former, which acts as a pressing or squeezing roller, is driven by contact. When the cloth leaves the squeezing rollers it is conducted under guide rollers K, and then between the second and third pegs E, and so on until several circuits are passing through the milk of lime L in tank A. Finally, the end is passed through a second guide M and then over a winch N to be deposited and spread in the lime pot, or kier in Fig. 202. This process is termed liming, and as the chain passes again and again through the milk of lime, it is impregnated with about 7 per cent. of its weight of lime. The speed of the machine, or else the number of times which the cloth passes through the milk of lime, is arranged to impart the desired degree of saturation.

The second part of this process is that of boiling the impregnated linen. This is done in the limepot O in Fig. 202. These pots or kiers are of different sizes, the one illustrated being about 9ft. in diameter and 8ft. deep. The cloth is spread in folds over the perforated grate P, and layer after layer distributed until the complete chain is enclosed. The hinged lid Q is now lowered by means of a chain and balance weight, and securely clamped down to the kier. Sometimes large stones are placed in the bottom of the kier, so that the chance of iron staining is minimised. A 6in tube R rises from near the bottom of the kier to within about a foot of the top and a 3in. steam pipe S enters the tube R as shown. As soon as the kier is charged and the lid secured, steam is admitted through the valve T. The cloth itself being saturated with milk of lime, provides the initial solution, and the steam which is condensed gradually increases the liquid contents of the kier. By the time the kier becomes hot, the volume of condensed steam and milk of lime is sufficiently large to prevent the cloth from being burnt. The boiling is continued for from six to ten hours, and during the process the liquid is intermittently forced up the tube R by the steam, technically termed vomiting, and after emerging from this tube the liquid impinges against the concaved surface of the plate U, from which it rebounds and is thus sprinkled or sprayed on the material somewhat as illustrated. This lime-boiling is for the purpose of removing some resinous and gummy matter from the cloth, as well as all substances which may have been added to the warp yarn during the dressing or starching process, and the cloth loses approximately 15 per cent. of its weight in the lime boil. The above substances must be removed before the actual bleaching process can be effective.

There is approximately the same weight of cloth introduced into the kier for each boil, but the chain of pieces in this stage is usually made up of various widths of cloth in order that the working length may be more or less constant, and thus provide sufficient pieces of cloth for the subsequent processes. This arrangement of different widths and different weights is clearly calculated to equalise the length, and thus provide more constant employment for the various finishing machines than would happen if one chain were made up of wide cloths and the next of narrow ones.

After the lime-boiling is finished, the valve V is opened and the liquid escapes through the pipe W, that which is in the cloth passes out of the kier through the perforated bottom plate P. Then the kier is flooded with fresh water to remove as much of the lime as possible before the chain is drawn from the kier into the washing machine.

In some bleachworks the lime-boiling is conducted in a newer form of kier, such as the Mather kier, made by Messrs Mather and Platt, Manchester. The grey cloth is drawn as usual from the grey-room D (Fig. 199), and is saturated with the milk of lime in the saturating machine J, from which it is drawn and then deposited in a kier wagon K immediately in front of the saturating machine. When the kier wagon K is charged with the cloth, it is run on the rails L to the turntable, and then rotated through 90° and run into form a thin milk of lime, and this liquid is introduced into the tank A either by pipe and valve, or by suitable vessels. Before the liquid enters the liming machine it is made to pass through a sieve in order that all unbroken lumps of $Ca(OH)_2$ may be arrested, and thus the substance is prevented from coming into direct contact with the cloth. Sometimes the slaked lime is enclosed in a perforated vessel and immersed in the water for the same reason.

The chain of pieces B, after leaving the grey-room, is first passed through a conveniently situated porcelain guide C, over the anti-friction roller D, between the first pair of pegs E, and then led between the top and bottom rollers F and G. The latter is placed in and out of action by fast and loose pulleys H and J, while the former, which acts as a pressing or squeezing roller, is driven by contact. When the cloth leaves the squeezing rollers it is conducted under guide rollers K, and then between the second and third pegs E, and so on until several circuits are passing through the milk of lime L in tank A. Finally, the end is passed through a second guide M and then over a winch N to be deposited and spread in the lime pot, or kier in Fig. 202. This process is termed liming, and as the chain passes again and again through the milk of lime, it is impregnated with about 7 per cent. of its weight of lime. The speed of the machine, or else the number of times which the cloth passes through the milk of lime, is arranged to impart the desired degree of saturation.

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The lime which remains in the cloth after the above-mentioned washing reacts with the hydrochloric acids as follows:—

$$Ca(OH)_2 + 2HCl \longrightarrow CaCl_2 + 2H_2O,$$

and the calcium chloride being soluble in water, may be removed by subsequent washing. The hydrochloric acid also decomposes lime soaps which are formed in the boiling.

Sulphuric acid is not used for souring after lime boiling, because insoluble calcium sulphate would be deposited, and would be rather difficult to remove from the folds of the cloth.

$$Ca(OH)_2 + H_2SO_4 \longrightarrow CaSO_4 + 2H_2O.$$

*Second Boil or Lye Boil.*—Soda ash, or soda ash and caustic soda combined, equal to about 5 per cent. of the weight of the cloth, is introduced for the second boil—say, 3 per cent. of soda ash and 2 per cent. of caustic soda. Practically the purest form of commercial soda ash contains 58 per cent. of sodium oxide, $Na_2O$, and is equivalent to 98 per cent. of $Na_2CO_3$. The cloth is boiled in this solution for from six to eight hours in the same manner as before. For a small bleachworks such as illustrated in Fig. 199 the same kier may be used alternately for lime-boiling and lye-boiling, but in large works the two operations are performed in separate vessels. Again, high-pressure vertical kiers, as indicated at Q, are often used for boiling. Sometimes a third boil is resorted to, but in every case the second or third boiling, as the case may be, terminates the actual boiling or cleaning process. The cloth is then washed again through a machine before it proceeds to the next stage.

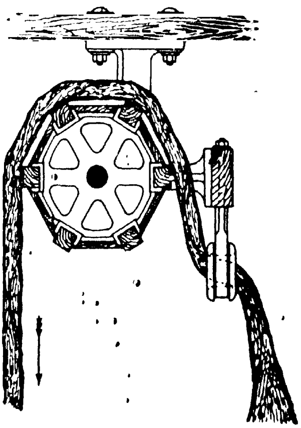


Fig. 203.

It might be mentioned here that in order to save handling as much as possible, all up-to-date bleachworks have installed a system of reels (*e.g.* N in Fig. 202), or grooved pulleys, or a combination of the two, by means of which the long lengths of cloth in a compressed form may be pulled from each tank or machine and deposited or led into the succeeding one. Fig. 203 illustrates, on a larger scale than N (Fig. 202), one of these reels or winches. It differs only from reel N in that it is provided with a pot guide. Apparatus is also provided in many cases for spreading the cloth evenly, layer after layer, in the kiers as illustrated in Fig. 202, although this operation is often considered to be more efficiently performed by hand. A man or boy, provided with wooden boots or clogs, enters the kier, and with his hands or a stick throws the cloth in folds as it drops from the guiding wince or reel, or from the grooved pulley.

CHEMICKING.—The cloth is now immersed in what is termed the chemic cistern or kieve (*see* V, Fig. 199), where it remains for from three to four hours or more. The liquor is a solution of bleaching powder (*i.e.* calcium hypochlorite or sodium hypochlorite of about ¾° Tw., sp. gr. 1.00375). Calcium hypochlorite is a double salt, and reacts with the hydrochloric acid as under:—

$$\begin{aligned} CaOCl_2 + 2HCl &\longrightarrow CaCl_2 + HCl + HOCl\,; \\ \text{and } HOCl &\longrightarrow HCl + O \end{aligned}$$

the oxidation of the colouring matter in the cloth being effected by the oxygen liberated by the decomposition of the hypochlorous acid.

If sodium hypochlorite is used, the action is represented as follows:—

$$\begin{aligned} NaOCl + HCl &\longrightarrow NaCl + HOCl\,; \\ \text{and } HOCl &\longrightarrow HCl + O, \end{aligned}$$

with a similar liberation of oxygen for bleaching.

Sulphuric acid may be used if desired with sodium hypochlorite. Thus:—

$$\begin{aligned} 2NaOCl + H_2SO_4 &\longrightarrow NA_2SO_4 + 2HOCl\,; \\ \text{and } 2HOCl &\longrightarrow 2HCl + O_2. \end{aligned}$$

After having been immersed in the first chemic cistern for the necessary time, the cloth is reeled into a second and similar chemic cistern, where it remains for from 2½ to 3 hours. The strength of the liquor in the two cisterns is the same. Occasionally, a third chemic cistern is used. As the cloth passes over the reels from cistern to cistern, the calcium hpyochlorite in the cloth is acted upon by the carbon dioxide and moisture in the air, calcium carbonate is formed in the cloth, and further oxygen is liberated, which acts on the colouring matter and thus helps the bleaching process.

$$CaOCl_2 + CO_2 + H_2O \longrightarrow CaCO_3 + HCl + HOCl\,;$$
$$\text{and } HOCl \longrightarrow HCl + O.$$

After leaving the last calcium hypochlorite cistern, the cloth is washed, and then soured in hydrochloric acid, in which the calcium carbonate is dissolved.

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2.$$

The chemic cisterns or kieves are shown at V in Fig 199, and the pump W alongside. For cotton goods the acid is pumped from the store tank into a cistern with a perforated bottom immediately above the cloth cistern; the liquid is thus spread on the cloth, and after passing between the various folds of cloth it returns to the store tank through a similar perforated bottom in the cloth cistern. A continuous circulation is thus kept up.

The cloth is now passed on to what is termed the "scald." This is the technical term often used for the boiling process after chemicking, in contradistinction to "lye-boiling," which indicates the process before chemicking. Soda ash equal to 1½ to 2½ per cent. of the weight of the cloth is used at this stage, and the scalding is continued for from three to six hours according to the weight and quality of the cloth.

*Second Chemick.*—This is performed in two or three cisterns as before, but with weaker solutions of calcium hypochlorite, about ½° Tw., sp. gr. 1.0025. One immersion is sometimes sufficient: the treatment naturally depends upon the type of cloth. Occasionally, the cloth is immersed in hydrochloric acid after the second chemick, but at other times it is just washed well through the washing machine.

*Second Scald.*—This is similar to the first scald, but it extends for from three to five hours with a 1 per cent. solution of soda ash.

*Third Chemick.*—The solution is again one of calcium hypochlorite, but of about ¼° Tw., sp. gr. 1.00125. The cloth is allowed to remain in this solution for from three to four hours. It is then washed in the machine, and run into hydrochloric-acid solution of ½° Tw., sp. gr. 1.0025, and allowed to remain there for two hours. After this, the cloth receives a double washing through the machines in order that all, or practically all, the chemicals may be removed.

The actual process of bleaching is now complete, but the chain of cloth, although intact, is still in a compressed form. Before it can undergo any actual finishing process, it is necessary that the twisted chain should be opened out, and this opening process is performed very efficiently, and very rapidly, by what is termed a "scutcher" or opening winch and plaiter (see Z, Fig. 199).

From the above description, which represents the bleaching operations as carried out entirely within the bleachhouse—a process which occupies about six days—it will be seen that the slaked lime, soda ash, and caustic soda are for the purpose of removing the waxy and similar substances so that they may be eliminated by washing; the bleaching-powder solution for supplying the necessary amount of oxygen to oxidise the colouring matter and thus bring the cloth to the required degree of whiteness; while the acid removes the last traces of bleaching powder, and also dissolves the compounds which are formed in the process, and which are insoluble in hot or cold water.

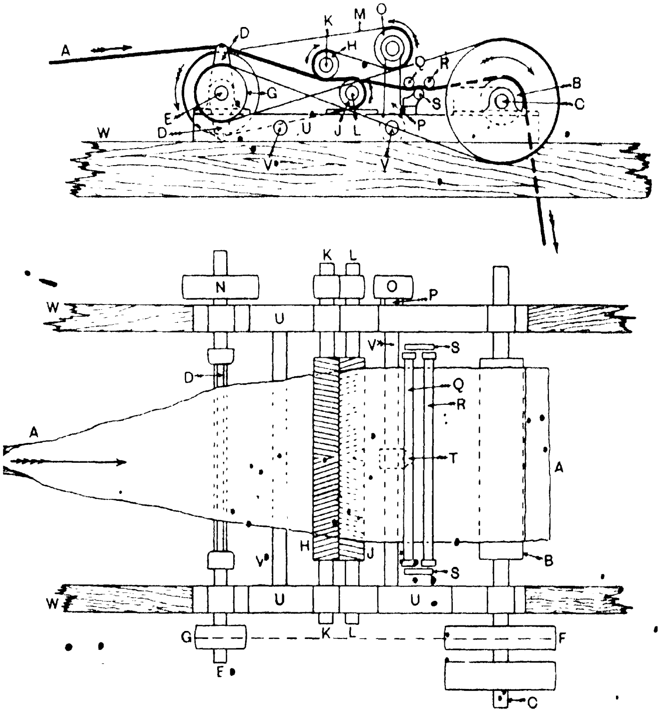
Somewhat similar processes are followed when the cloth is bleached partially in the bleachhouse and partially in the fields. Thus, for example, for high colour sheetings and similar fabrics there may be three or four boils, and then the cloth may be spread on the greens and allowed to remain for from two to four days. It is then lifted, taken to the bleachhouse and boiled, then grassed again for a similar period, boiled again, grassed a third time, and then chemicked. Such a process naturally takes much more time, and very much more handling, than does cloth which is bleached entirely within the bleachhouse. Again, cloth exposed in the fields is subject to ravages by field mice; and, in addition, when lifted, may contain small stones or be stained by soot and other dirt. In the former case it is clear that damages may result when the cloth and stones pass between heavy rollers, and the stains have to be removed by soap, water, and rubbing-boards, or by some such method—operations which clearly demand much attention and increase the cost of the bleaching. On the other hand, the process is very gradual, and not nearly so severe a treatment as the quicker method. For the general run of fabrics the house bleaching appears to yield quite satisfactory results; but for weak, delicate, or expensive fabrics, it is desirable to resort to field work, and also to employ a bleaching agent such as sodium hypochlorite, sodium peroxide, hydrogen peroxide, etc., all of which have a milder action on the fabric, and bleach much more slowly than those used for the quicker process.

The plan of working varies slightly in different districts, and also in different bleachhouses in the same district, and slight differences are found for treating different kinds of fabrics. Thus, for small articles the wash-mill or stocks T (Fig. 199), or wash-wheels, may be used, while the rubbing-boards U are seldom used except where field bleaching is practised.

# CHAPTER XVII

## SCUTCHING AND EXPANDING

THE scutcher, which, as already stated, opens out the cloth from its compressed form, is usually situated in close proximity to the starching mangles. In principle all scutchers are the same, and one of the many types is that made by Mr W. H. Harrop, Salford, Manchester, and illustrated in Figs. 204 and 205. The cloth A, in a crushed condition, is drawn from the last washing machine by the roller B on the main shaft C of the scutcher. One roller B only is shown in the figures, and this is usually sufficient when the cloth passes directly from the scutching machine to the water mangle or the starch mangle; when, however, the cloth is deposited in folds, with or without a plaiting motion, two delivery rollers B are used. The cloth comes first into contact with the rapidly revolving beaters D on the shaft E. The latter rotates at 300 to 400revs. per min., and receives its motion direct from the main shaft C by a crossed belt as shown on the pulleys F and G. It will thus be seen that the beaters D revolve against the cloth, and in the opposite direction to that in which the cloth is travelling. This rapid beating action shakes out or opens the twist in the cloth, while the creases are removed as the cloth passes between the two scrolls H and J. The scrolls, which are grooved left and right from the centre, as illustrated, are secured on the shafts K and L, and both are rotated in the opposite direction to that in which the cloth is travelling by means of an endless belt M. The endless belt is driven by the pulley N on the shaft E, and kept taut by means of a tension pulley O carried on the swinging arm P. By this arrangement the cloth is straightened out almost perfectly by the time it leaves the scrolls H and J. It is essential that the selvages of the cloth should be kept as near as possible equidistant from the two ends of the scroll, and this is done ingeniously by what is termed the governor. This appliance consists of two metal rollers Q and R furnished with self-lubricating bearings by means of studs fixed in the ends of the frame S. The cloth A passes under the rollers



Figs. 204 and 205.

Q and R as shown, and over the frame S, the whole being pivoted at the centre T. When the cloth is passing centrally through the governor the latter is parallel to the scrolls H and J and to the delivery rollers B; but should a greater width of cloth enter on one side of the governor than on the other side, the extra width causes the governor to turn on its pivot T, and thus the rollers Q and R revolve in an oblique direction, which tends to draw and to direct the cloth again into the central position. An exaggerated illustration of this oblique position of the rollers Q and R with respect to the rollers B is shown in Fig. 206, from which it will be seen that the rotation of the governor rollers will direct the cloth to the delivery rollers B in the direction of the arrow X. In actual work the displacement of the rollers from the normal position is only slight. Returning to Figs. 204 and 205, it will be observed that the scutching apparatus is fixed to a suitable iron base U, the two sides of which are kept in their proper positions by steel bars V, and the whole is supported at a convenient height on beams W. As mentioned above, only one delivery roller is illustrated in Figs. 204 and 205, and but two are shown in Fig. 206.

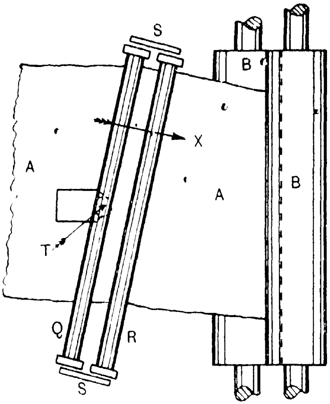


Fig. 206.

Another, but simpler, form of scutcher is illustrated in Fig. 207.

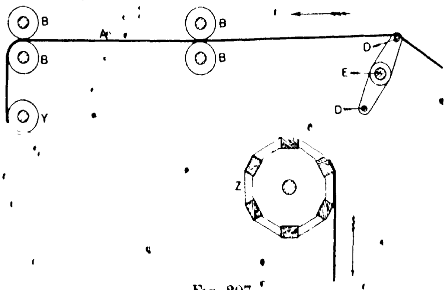


Fig. 207.

Similar beaters D on the shaft E take out the twist, and the cloth A is drawn forward by two pairs of drawing rollers B, then under a guide roller Y, and finally over a winch or reel Z to be plaited by hand on to a conveniently placed table. Proper mechanical plaiters may be fixed to any of these scutchers.

The actual finishing process commences at this stage. If the cloth is not fed mechanically from the scutcher, it is usually placed

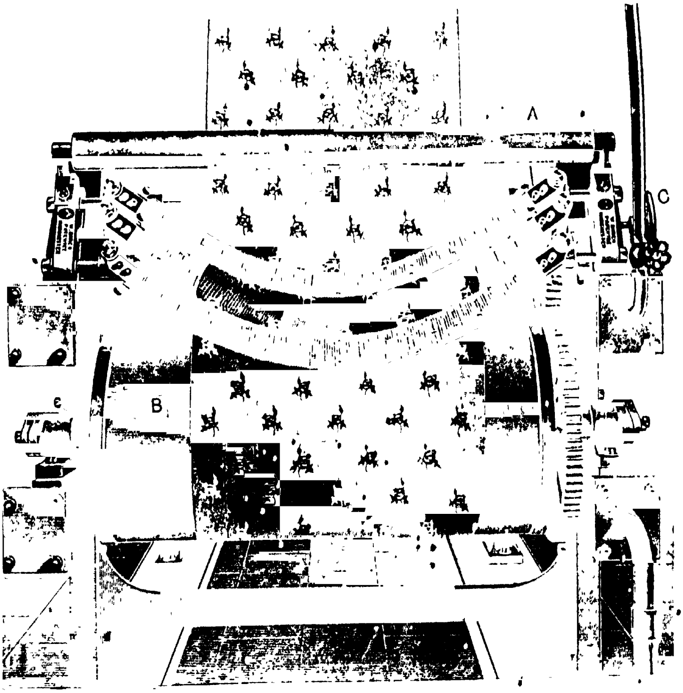


Fig. 208

in loose folds behind a starching mangle such as that illustrated in Figs. 189 to 191 (pp. 232–233). After the cloth has passed through the starch mixture, which is made from farina, wheat, or other suitable cereal, and water, it is often led through a blue solution made from aniline, ultramarine, Smalt's blue, etc., and from this liquid it is guided on to the pans or cylinders of the drying machine as illustrated in the above-mentioned Fig. 189. It is usually the plain and twilled goods which are dried on the pans, the damasks and other figured goods, especially the fine ones, being treated differently.

Although the cloth is practically straight both when it enters and when it leaves the starching and bluing mangle, it is essential that it should be further stretched immediately before it reaches the first pan of the drying machine. This function is performed by one or other of the many types of expanders, and the apparatus invariably occupies a position about the point K in Fig. 189. Some of these expanders are in the form of scrolls (see H and J in Figs. 204 and 205), and may contain double or triple sets; others are similar scrolls, the two parts from the centre forming an angle less than 180°, and often termed angular scroll guides; then there are scrimp rails or fishbacks made of brass, ebonite, porcelain, or iron, curved rubber guides, three- and five-bar regulating expanders, adjustable bell-crank lever expander, bent bar expander, and float expanders. In some cases two types are used on the same machine A very common type of expander is that illustrated in Fig. 208,

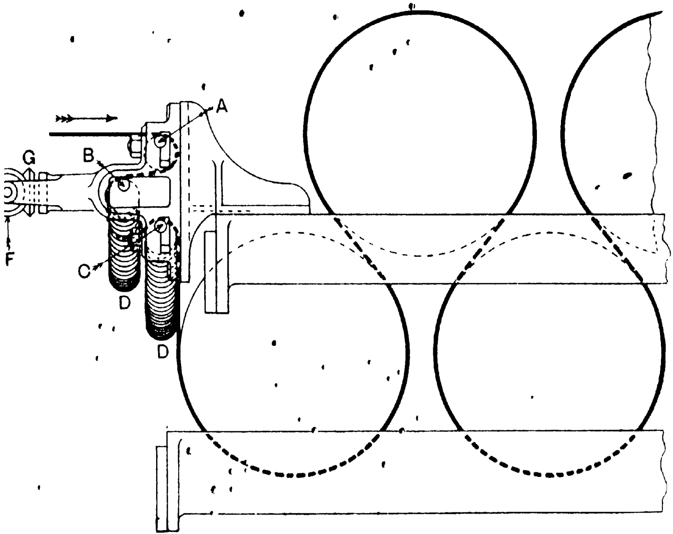
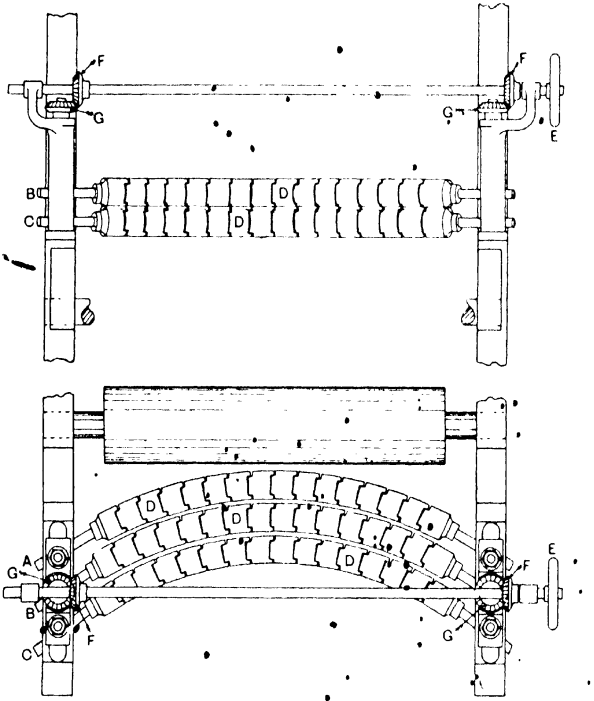


Fig. 209.

and made by the Exors. of William Birch, Lower Broughton, Manchester. The cloth from the starching or bluing mangle first passes under roller A, very often made of rubber, and is then threaded under, over, and under the three bars as shown, and ulti-



Figs. 210 and 211.

mately guided on to the first pan B. The bars are constructed of flexible steel, upon each of which are mounted several interlocking revolving rollers or pulleys. Each roller runs on its own parallel bearing of special construction, so arranged as to dispense with lubrication, and thus eliminate danger of stains. Left and right-handed screws operated by the wheel C permit of the end supports being moved nearer to or farther from each other within limits, and thus various degrees of curvature of the bars can be obtained without fear of the rollers losing their grip of the cloth.

The efficiency of the type of expander illustrated in Fig. 208 has been considerably increased by Messrs. Birch's new form of "Bent Bar Expander," illustrated in Figs. 209 to 213 inclusive. Fig. 209 shows the method of fixing the expander to the feed end of a drying machine. Figs. 210, 211, and 212 show respectively an end elevation, a plan, and a side elevation of the same expander arranged for working in conjunction with a mangle; while Fig. 213 is a general perspective view of the complete apparatus. The expander consists of three curved steel bars A, B, and C, on which revolve the brass bobbins or clutches D. The variation of stretch is obtained by raising or lowering the centre bar B by means of the hand-wheel E, bevel-wheels F and G, and square-threaded screws in the supporting blocks of the centre bar, the whole forming a stable, efficient, and satisfactory expander. In cases where there is any danger of rust, such as in water mangles, the brass bobbins revolve on brass sleeves, so that there is scarcely any chance of rust from the steel bars reaching the cloth.

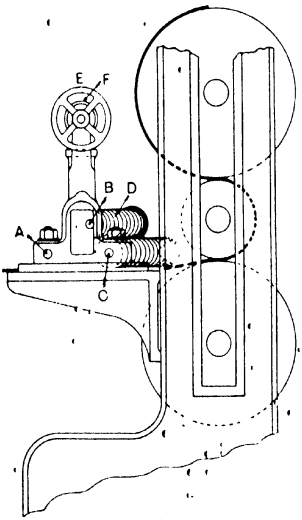


Fig. 212.

The adjustable bell-crank lever expander as made by Messrs Birch is illustrated in Figs. 214 and 215. The former shows the construction, while the latter is a perspective view of the complete apparatus. Three studs A, B, and C are fixed to the bedplate, and upon these are fulcrumed the knuckles $A^1$ and $B^1$, and the quadrant $C^1$. Three studs D, E, and F are cast upon the knuckles and quadrant, and a short bar G is dropped on to these studs. The three parts are thus compounded. Shaft H extends from end to

Fig. 213

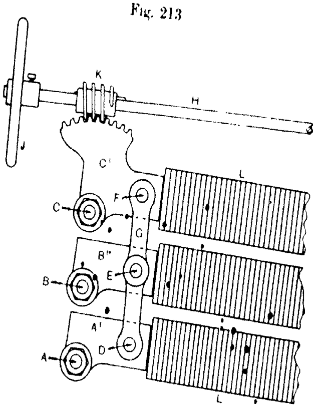


Fig. 214

Fig. 215.

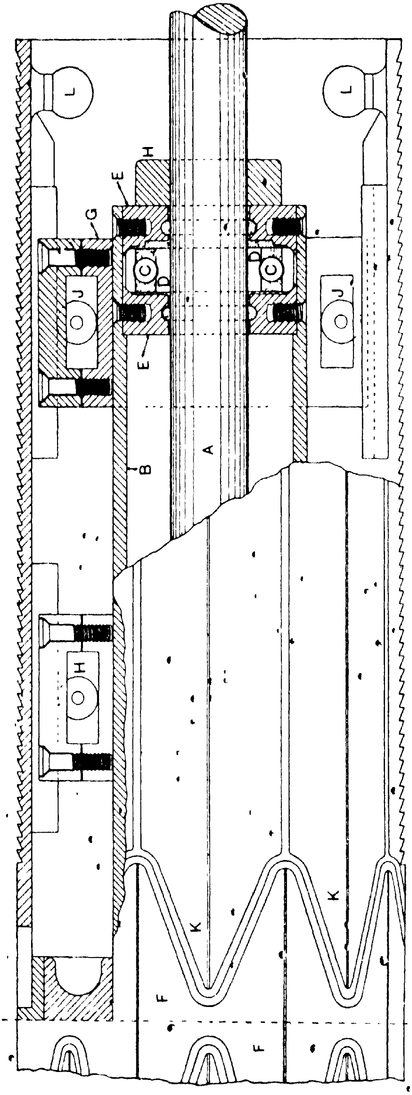


Fig 216

end of the framework, and carries a left-hand worm at one end and a similar but right-hand worm at the other end. It is therefore clear that when the hand-wheel J is rotated, both worms K will operate their respective quadrants $C^1$. Knuckles and quadrants $A^1$, $B^1$, and $C^1$ carry iron rods upon which brass sleeves rotate, hence, as each quadrant moves about stud C as fulcrum, its corresponding set of bars and sleeves L will move out or in according to the direction in which the worm K rotates. When the worms are in contact with the teeth of the inner parts of the quadrants $C^1$, the sleeves L are parallel to the rod H, and a minimum stretch obtains; but when the worms are in contact with the teeth at the opposite ends of the quadrants, the outer ends of each set of sleeves are moved outwards as illustrated in Fig. 215, and the maximum distending power is exerted on the fabric.

Another very successful expander is that illustrated in Figs. 216 and 217. It is termed the "Revolution Expander," and is made by Mr W. H. Harrop, Salford, Manchester. The central fixed shaft A is carried in suitable brackets which are fixed to the drying machine frame in any convenient position for enabling the expander to guide the cloth on to the first drying pan. Running loosely on the shaft A is a steel sleeve B provided at its ends with ball bearings C and D; the latter are held sideways between steel rings E which form grease chambers. The grease is supplied to the chambers by means of a pipe which is sunk into the fixed shaft A, and the pipe naturally leads to all the chambers. The ogee-shaped central part F is fixed to the sleeve B, and so are all the octagonal parts G. Collars H serve to hold the sleeve and all its component parts in proper location on the shaft. Rollers J are inserted between the upper and lower parts of the octagons G, and the floats K rest upon and move with the rollers. In addition, the two inner and lower projections of the float slide under the ledges of the upper part of the octagons G. As the sleeve B and its components revolve on the shaft A, the floats are caused to move outwards when they are approaching the drying pan, and to move inwards to the normal position after the cloth from such float has been delivered to the pan. Thus each float, in regular succession, is gradually moved outwards every revolution as it carries its own section of cloth to

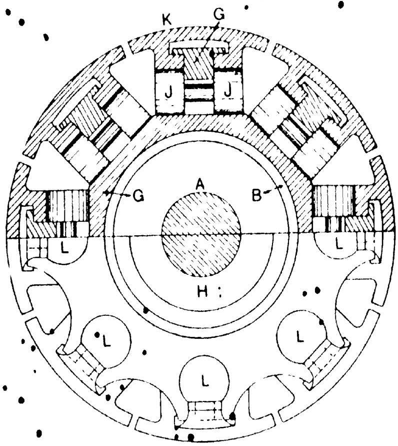


Fig. 217.

the pan, and then returns ready to carry forward a new supply and to stretch it in its movement. This lateral or sliding movement of the floats is obtained by means of a cam which is secured to the shaft A, and so adjusted that the float is made to occupy its extreme outward position just at the point where the cloth leaves the float to join the drying pan. The ball-shaped studs L run in the grooves of this cam, and it is naturally through this connection that the floats move laterally while the roller is rotating. The cams may be adjusted to any convenient angle by left- and right-hand screws, nuts, and arms, and each cam is provided with loose gun-metal rings that travel round with the ball studs, all wear taking place on the cam ring.

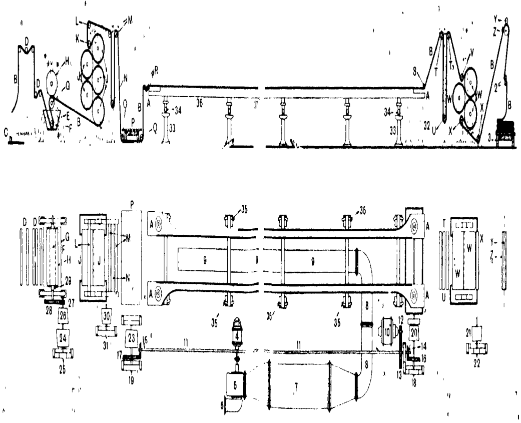
# CHAPTER XVIII

## STENTERING, JIGGING, GUIDING, AND FEEDING

ALTHOUGH certain types of heavy cloth, such as many of those made from jute, are capable of being run on to the drying pans or cylinders quite successfully without any kind of expander, some type of expander is desirable and practically necessary for all kinds of thin fabrics which are run over the pans, and particularly is this the case when it is desired that the cloth should be perfectly free from creases when it leaves the drying pans. On the other hand, there are many types of cloth which are not allowed to come into contact with heated cylinders. These are usually dried, or partially dried and stretched, on the stentering or tentering machines. Again, one or two cylinders or pans are sometimes used in conjunction with the stentering machine. Damask cloths are very often stretched, and sometimes partially dried, on the stentering machines alone, while in other cases the stenter and dryer are used in combination for the stretching and drying of damasks, printed goods, and fancy fabrics generally. When the cloth is dried over the pans and then further stretched on the stentering machine, it is usual to have some compensating rollers or apparatus between the two machines so that the cloth may pass freely through each machine without injury.

*Stentering and Jigging Machines.*—Stenters in their simplest form are all more or less alike, and their chief parts are the two endless lengths or chains of clips which grip the cloth and carry it forward; the parts for relieving both sides of the cloth from the clips as each portion reaches the end of the machine; the mechanism for driving the chains; and the hot-air pipes where necessary. The stenter itself is illustrated between the two points A, A in Figs. 218 and 219, which show elevation and plan, both partly diagrammatic, of a complete range of starching, pan-drying, stentering, hot-air drying, compensating apparatus, selvage drying, and plaiting motion, as made by Messrs J. H. Riley and Co., Limited, Bury. The actual way in which the cloth is gripped and stretched will be explained shortly. The cloth B, shown in heavy line, is first brought to the stillage C or else in a barrow, and passed over and under a suitable number of tension rails D. It is then guided under roller E in starch box F, and then between the brass and sycamore bowls G and H, of 9in. and 20in. diameter respectively. The frameworks of all the machines, except the supports of the stenter rails, has been dotted so that it would not interfere with the more essential parts of the work so far as this illustration is concerned. After the superfluous starch has been squeezed out of the cloth by the rollers of the starch mangle, in this case the rollers G and H of the two-bowl mangle, the cloth B is fed on to the drying cylinders J but previous to reaching the bottom pan J it would be slightly stretched by one or other of the many types of expanders which are illustrated in Figs 208 to 217 pp. 263 to 269. After the cloth leaves the top pan J it is deflected to the guide roller K in order to utilise the heating surface of the upper pan as much as possible, and then passes over guide roller L to the compensating apparatus, which consists of two fixed rollers M and a rising and falling roller N. The cloth passes under the latter but over the two former, and is then deflected under guide roller O, under stool P, under guide roller Q, and then between the guide and tensions rollers R of the stenter into the jaws of the travelling clips. These clips grip the cloth, carry it forward over the whole length of the stenter, and deliver it at the other end under roller S, from which it passes to the second compensating apparatus, consisting of fixed rollers T and movable roller U. The cloth then passes under roller V, over a second set of pans W, around guide rollers X, and finally to the nip of the rollers Y and Z and to the plaiting rollers 2, from which it is delivered in the well-known plaits or folds on to a further stool or stillage 3, or else into a large barrow.

It will be seen that the cloth is dried in stages: (1) Partially by means of heated pans J; (2) by a system of hot pipes under the stenter, and (3) by the heated pans W. All parts of the cloth, except the selvages, are practically dry when the cloth leaves the stenter, and the drying pans W are often introduced to dry the



Figs. 2[illegible] and 210.

selvages, which have been kept from contact with the hot air on account of their being gripped by the jaws of the clips.

The arrangement for the provision of hot air is shown only in the plan view (Fig. 219). A small motor 4 drives a fan 5 which draws air through the duct 6 and delivers it into the tubular heater 7. The heater works at boiler pressure, and may have a heating surface of 2000 sq. ft. or more. It is usually placed in a separate building or room, and so is the stenter, and the pipes 8 leading from the heater pass either under or over the stenter according to which position happens to be the more suitable. They are almost invariably, however, under the stenter as illustrated, and at various points in the straight length of pipes 9 are inserted double-ended outlet pipes from which the hot air is forced. Each outlet pipe is provided with a swivel door so that the quantity of hot air from each may be varied, and also the current of air may be directed on to the cloth at any desired angle.

The method of driving the various parts is illustrated only in Fig. 219. For a 40ft. stenter such as that illustrated between A and A, the over-all length of the complete range of machines is 74ft., and a 25h.p. motor 10 is used to convey the necessary power. The motor drives the main shaft 11 by means of the pinion 12 and wheel 13. At the ends of the shaft 11 are two small bevel pinions 14 and 15 which drive respectively bevel-wheels 16 and 17 on shafts 18 and 19. A belt is passed over the cone pulley 20 on shaft 18 and cone pulley 21 on shaft 22; each cone being about three times the width of the belt in order to allow plenty of movement for the latter. By this arrangement the pans W are driven. Similar cone pulleys 23 and 24 are fixed on shafts 19 and 25, and the latter is driven by a belt over cone pulleys 23 and 24. Shaft 25 also carries cone pulley 26 and pinion 27; the latter drives wheel 28 on mangle roller shaft 29, while a belt from cone pulley 26 to cone pulley 30 drives shaft 31, which communicates its motion to the drying pans J. Shaft 18 also carries the power to the headstock of the stenter, the framework (Fig. 218), only being indicated at 32. The stenter rails themselves are supported by parts 33 and 34; the upper faces of 33 are curved as at 35, for reasons to be explained later. The method of driving stenters will be illustrated in other drawings. The introduction of cone pulleys provides facilities for regulating the speeds of the successive parts so that the speeds may be as nearly the same as possible. The compensating apparatus completes the scheme, for any slight irregularity in the speed is immediately met by the raising or lowering of the rollers N and U, and thus each machine, as it were, works independently of any other, and still all are combined to manipulate long lengths of cloth without damage.

The clip which grips the selvage of the cloth is as ingenious as it is simple, and it will perhaps be wise at this stage to consider how each clip works. There are several styles of clips, electrical and mechanical, but they all operate on practically the same principle. Figs. 220 and 221 illustrate a very common and successful type.

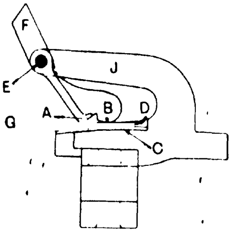


Fig 220

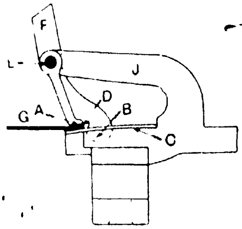


Fig 221.

The object of the clips is to take hold of the fabric near the selvages, but not to grip the cloth at any part other than the selvages. When the cloth enters between the two sets of clips at the left-hand end or feed end of the stenter A in Figs. 218 and 219, the rails are nearer to each other at that point than at any other. Although not shown inclined in Figs. 218 and 219, the two rails or the first pair of rails 36 are inclined, and gradually widen out until they reach the maximum distance at the junction between the first pair 36 and the second pair 37. From this point onwards the remainder of the rails are parallel. Consequently, when the cloth enters the clips on the first pair of rails 36, there is usually about two inches of cloth inside the clip beyond the gripping face A (Fig. 220). In this figure the tongue B (there are really two, but one only can be seen in this view) and the heel of the gripping face A are resting upon the cloth G, and the latter upon the baseplate C, while the extreme end of the selvage of the cloth is at D. Parts A and B are fulcrumed at E, and the lever extends to F as shown. As the two chains of clips move forward over the inclined rails it will be evident that the distance between the clips will increase gradually and proportionately to the inclination of the rails, and at the same time the clips will tend to leave the cloth G. This continues until the extreme outer edge of the selvage D passes over two slots in the baseplate C, and thus allows the two tongues to drop into the slots as indicated in Fig. 221 Then, and not until this happens, can the gripping face A grip the cloth, and obviously by this arrangement it can grip the cloth at no point except the selvage. Any further outward movement on the part of the two sets of grips merely causes each grip to secure

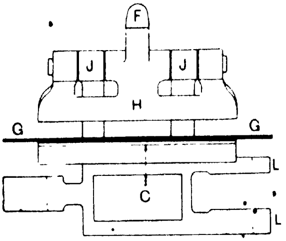


Fig. 222

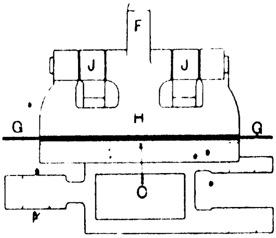


Fig. 223

the cloth more firmly, and at the same time to stretch it gradually until the desired width is reached. The stretching operation is in reality the chief function of the whole apparatus, and the gradual development of a brocade or damask pattern under the influence of this ingenious piece of mechanism is indeed a pretty sight.

Other views of the grip appear in Figs. 222, 223 and 224, which show respectively a front view of clip with jaw H open, a front view of clip with jaw H closed on cloth G, and a back view of clip with jaw H closed with the cloth G gripped between the gripping face A of the jaw H and the baseplate C. In this view the two tongues B are shown as having entered their corresponding slots. Parts J are simply the two supports in which the jaw H as a whole is fulcrumed. It will be seen clearly that the projecting part K of Fig. 223 can fit into the gap between the two parts L of Fig. 222, and thus a chain of clips of any suitable length can be formed for any kind of stenter.

In the finishing of many linen fabrics—indeed, in nearly all cases—the starching mangle is worked separately, or else in conjunction with a set of drying pans, and rarely in combination with the stenter. When the stenter is used independently of any other machine, which is often the case for linen, the cloth is placed at the feed end of the stenter either in loose folds or wound upon a beam. In some finishing departments the damasks are run through two stenters—the first for the initial stretching, and the second for the final stretching; but in most cases the cloth passes through one stenter only. Under such circumstances it is clear that the machine will appear much more simple than the arrangement illustrated in Figs. 218 and 219, and will indeed consist only of that part marked A, A in addition to a plaiting down motion. If the cloth were in loose folds it would be placed on the stillage or stool P, which is used in the full arrangement illustrated as a stool upon which the attendant may stand in order to attend to the cloth as it enters the stenter proper.

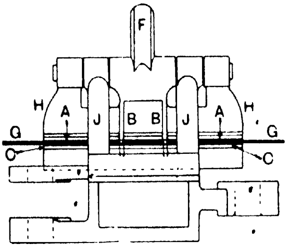


Fig 224

It is, of course, essential that the cloth should be guided between the jaws of the clips which are open just where the cloth enters the machine. This operation may be and often is done manually, but it can be done more correctly and much more cheaply by an automatic feeder, or by an automatic guider and feeder combined. There are two or three different types of automatic guiders and feeders, but that made by Messrs Daniel Foxwell and Son, Manchester, appears to be utilised most in the linen industry; it is found to be very safe in its action and very efficient, and is equally suitable for other fabrics. The most important parts of this apparatus are illustrated in elevation and plan in Figs. 225 and 226. In the elevation, one part (C) of the apparatus—the feeder—is shown bolted to an arm B of the stenter rail A, and just sufficient of the latter is illustrated to show the connection between the two

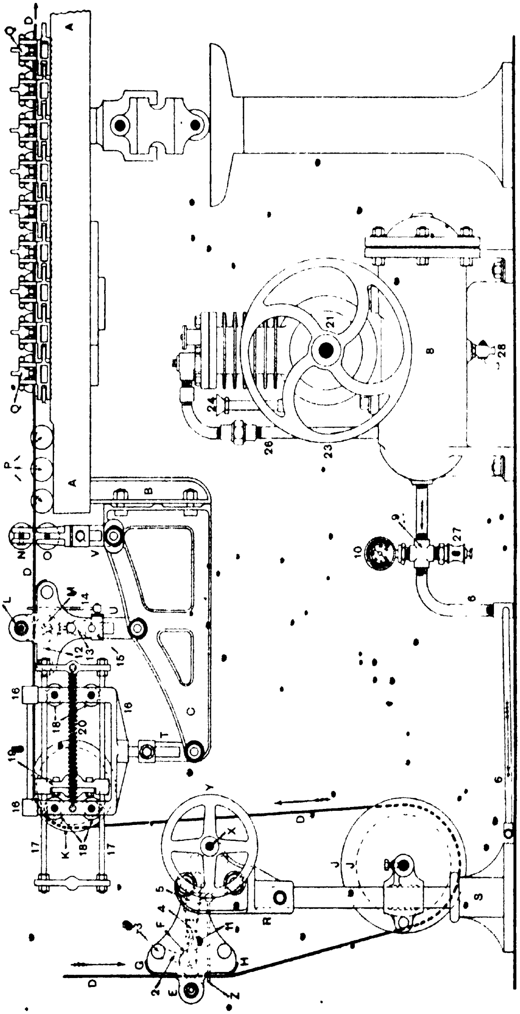

Q
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Fig. 225.

and the method of working. The stenter itself in Figs. 218 and 219 is 40ft. long, but they are sometimes 90ft. in length. This length is probably necessary when the fabrics travel at 100 yds. per minute, as in certain sections of the cotton trade; but for linen a much slower speed (say, about 50 to 60yds. per min.) is adopted, and the stenters are usually from 30ft. to 40ft. in length.

The automatic guider and feeder is shown to the left of stenter rail A in Fig. 225, and the cloth D, in heavy lines, comes from any convenient source and moves in the direction indicated by the arrows. It passes between the cone rollers E and F, being guided to and from these by guide-plates G and H or by anti-friction rollers, and then partially round large wooden cones J, over further cones K, between the feeder rollers L and M and the retaining rollers N and O. It may then be guided between or straight over the stenter rails P as shown, and between the jaws of the clips Q, nine of which are shown as forming part of an endless chain of clips which, with the outside half of the chain and the companion chain of clips on the opposite stenter rail, carry the cloth forward and deliver it as previously explained. The guider is supported by an ajustable bracket R and stand S, and the former can thus be raised or lowered to place the headstock of the guider in the most suitable position. Similar adjustments are provided with brackets T, U, and V of the frame C for the various parts of the feeder.

In many instances the guider is found to work quite satisfactorily without the feeder, the latter, however, makes the apparatus more complete and certain. When the two are working in unison as illustrated, the guider performs the rough centring of the fabric, and the more delicate and smaller adjustments are performed by the feeder.

From Fig. 226 it will be seen that there are two sets of cones E, one on each side of the machine, and since it is essential that all widths of cloths, within reasonable limits, should be capable of being treated by the same apparatus and in the same machine, provision is made for this purpose. The cones E and F and all contiguous parts are supported by two brackets W on left-hand and right-hand threaded rod X, and the two sets of cones can therefore be moved nearer to or farther from each other, as desired, by turning the hand-wheel Y. Similar adjustments are necessary

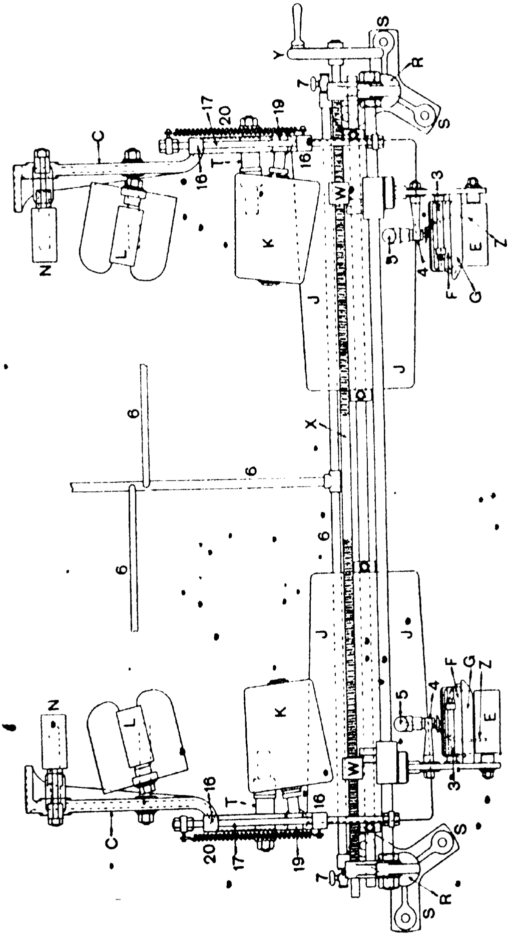


Fig. 226

for the cones and all parts of the feeding apparatus, but these move bodily with the rails A of the stenter, for it is obvious that it is also necessary to alter the distance between the two rails of the stenter so that the two sets of clips may be adjusted to suit the required width of cloth.

The object of the guider and feeder is to keep the cloth centrally situated so that the selvages and the inner lengths of clips shall be in the same planes, and both parts of the apparatus perform this work. When the cloth is running centrally and in its proper position for the clips, the cones E and F on both sides of the machine are touching the cloth, and the selvages are inside and clear of the aluminium levers Z. The cloth, by reason of the pulling action of the clips Q, passes freely and easily between the two rotating cones E and F, one or both of which may be covered with rubber. In general, cone E is covered with a rubber sleeve, and cone F is a corrugated brass one.

Rollers F and bell-crank levers 2 are fulcrumed at 3, and when the cloth is in the centre, as explained above, both rollers F are pressed forward by a jet of compressed air which issues from an orifice in 4 against the face 11 of the short arm of bell-crank lever 2. The opening and closing of the orifices are due to the action of the aluminium lever Z on the valve 5, and suitable rubber tubes convey the compressed air through pipes 6. The rubber tubes are not shown in Figs. 225 and 226, but the brass valves to which they are connected for the guider are marked 7 in Fig. 226, and similar valves are provided for the feeder. The compressed air flows from the receiver 8 through valve 9, and its pressure is indicated on gauge 10.

As already stated, the two aluminium levers Z are clear of the selvages of the cloth when the latter is centrally situated; but should the cloth, owing to irregular folds, pass either to the left or to the right, the corresponding selvage would come into contact with the aluminium lever, which would, in consequence, be forced slightly outwards. The movement outwards of lever Z closes the air-valve 5, and immediately either valve 5 is closed, the corresponding bell-crank lever 2, in virtue of gravity, falls to its lowest and vertical position, and in doing so it withdraws the cone F from contact with the cloth. The opposite selvage of the cloth—that is, the one which is still in contact with both rollers E and F—creeps gradually up towards the thicker diameters of the cones, and thus draws the cloth a little to that side and in particular draws the other selvage from contact with the lever Z, the latter then returns to its normal position—an action which again opens the valve 5 and allows the jet of compressed air to come against the face 11 of the short arm of bell-crank lever 2, and to carry the cone F into contact with the cloth. Any deviation from the straight path thus causes one or other of the aluminium levers Z to close its valve 5 and to cut off the jet of air, the cloth is, in consequence, kept approximately in its central position. The action will take place more frequently with loosely folded pieces than with pieces which are on a roller, but in any case the guider acts as stated, and acts successfully even without the feeder. When the feeder is used, its action is identical with that of the guider, but the movements of the cloth from side to side, although very frequent, are through short distances. In this case the cone M, which is carried by bell-crank lever 12, is raised or lowered by the presence or absence of the compressed-air jet from part 13; and the aluminium lever 14 acts upon valve 15 in virtue of the pressure of the selvages of the cloth in precisely the same way as described in connection with the similar aluminium levers Z and valve 5.

Angle bracket T is supported by a stud in the framework, and itself supports the winch bracket 16. Slide rods 17 and grooved pulleys 18 enable the winch 19 and the cone pulley K to slide backwards and forwards to take up the slack of the cloth, especially when the apparatus is used in conjunction with a jigging stenter. The spring 20 returns the winch to its normal position.

The relative sizes of the various parts in Fig. 225 may be compared with the clips in Figs. 222, 223, and 224. The apparatus is here described for use in its simplest form and in connection with linen and ordinary cotton goods, but it is applicable to all kinds of fabrics, all of which it keeps perfectly straight; it removes creases, and if the cloth is of an elastic or curly nature removes the curls from the selvages.

The combined air compressor 21 and receiver 8 are shown in Fig. 225 from the pulley side. This machine is belt-driven from the the fast and loose pulleys 23, and it is capable of supplying air to about 8 guiders and feeders, or to 14 guiders. It is 3½in. bore, 4in stroke, and is splash-lubricated. The breather and oil inlet pipe is at 24, and the level of the oil is indicated in a gauge glass. The compressed air is delivered into the receiver through pipe 26, and passes, as before mentioned, to the various guiding and feeding apparatus, through pressure valve 9, the pressure being indicated on gauge 10. The apparatus is tested up to 60lb., but the usual working pressure is 30lb.; and when the pressure exceeds this, the relief valve 27 is opened and the air escapes there. A drain cock 28 and other necessary fittings are provided to render the equipment as complete and as efficient as possible.

The ordinary stenter is used, as already mentioned, for damasks, napkins, and fancy goods generally, and in most cases where it is desired to keep the cloth from contact with hot cylinders, or where the object is simply stretching and not drying and stretching. There are, however, certain types of cloth, mostly plain weave, which are stretched and dried on special kinds of stenters, termed jigging stenters, to obtain what is known as the "elastic" finish.

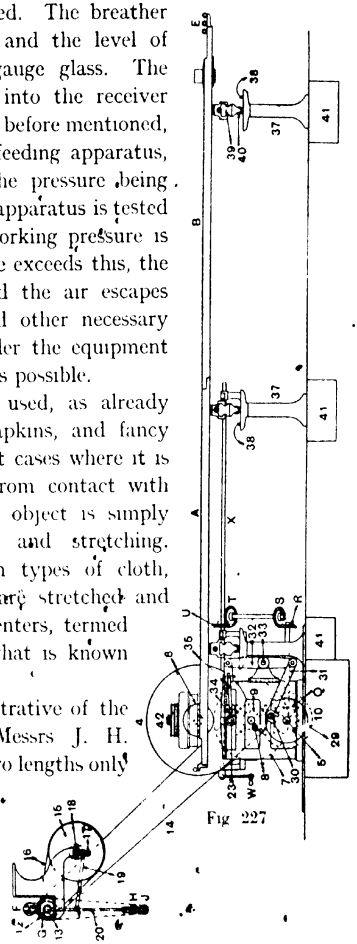


Fig 227

Figs. 227 to 229 are illustrative of the jigging stenter made by Messrs J. H. Riley & Co., Ltd., Bury. Two lengths only of stenter rails, A and B, are shown in Figs. 227 and 228. Motion to the two sets of clips is imparted by two chains and two sprocket wheels C; the chains naturally extend over the full length of the stenter rails, and pass round similar sprocket wheels represented by circles D. In ordinary stentering the cloth passes between tension rails E, follows the course of the stenter rails B and A and all rails between them, and is delivered at the opposite end by the rollers F, G, H, and J of the plaiting apparatus. The sprocket wheels C are power-driven, and the method of conveying the power will be illustrated directly. The two stenter rails A near the delivery end (Fig. 228), are parallel, and so are all the remainder except the first pair B at the feed end. These swivel about the joints K, and their outer ends may be adjusted at will to suit any reasonable degree of inclination. The adjustment for this inclination is made by hand-wheels L and the left-hand and right-hand threaded rod M, which work in correspondingly threaded bosses at the base of the stenter rails B. The cloth may thus enter easily into the grips, and be gradually extended until it assumes the width desired. As each grip approaches the inner edge or periphery of sprocket wheel C, or the outer edge of sprocket wheel D, the upper projecting part F of the clip lever (see Figs. 220 to 225) enters under inclined plates, one of which is situated immediately above baseplate N (Fig. 228), and the other immediately above baseplate O; both inclined

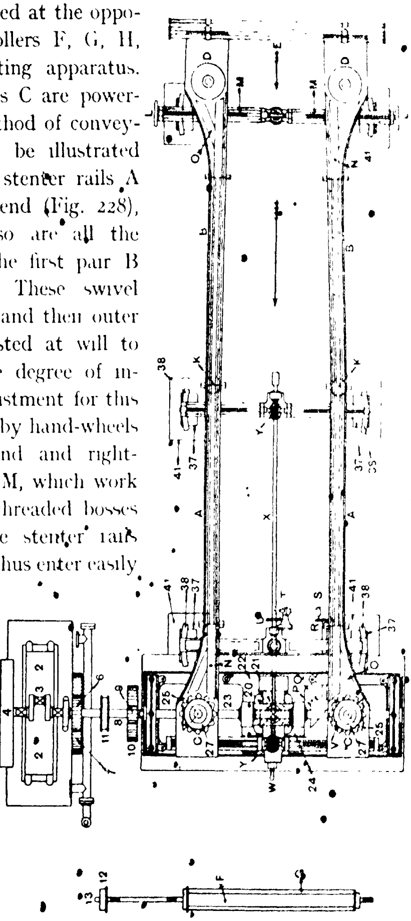


Fig. 228

plates extend the required distance round the sprocket wheels C and D. The plates are, of course, inclined to the stenter rails and to the path followed by the upper part F of the lever clips when the latter are not in contact with the plates, but immediately each clip enters under its corresponding inclined plate, the upper part F is under the influence of the plate, and as the clip moves forward the part F is forced down gradually, and eventually sufficiently far to lift up the jaw H to the position illustrated in Fig. 222, and thus each clip is withdrawn from the selvage of the cloth just before it commences to rotate for the return journey at the delivery end, and in a similar way to present an open jaw for the cloth to enter as it is moving round the sprocket wheel D at the feed end (Fig. 228).

The desired width between all the parallel rails is obtained by moving the rails nearer to or farther from each other. They are moved in one direction by bevel wheels P, Q, R, S, T, and U, and in the other direction by V, Q, R, S, T, and U; all the wheels are operated by power, P or V being placed into gear with Q according to which direction the rails have to be moved. Slight alterations in the distance between the rails may be made manually by handle W. It will be seen that in every case the central shaft X is rotated, and since this shaft carries a worm immediately under worm-wheel Y, and a similar worm under all the other cross rails, it follows that all the parallel rails move either in or out simultaneously.

It will perhaps be best now to consider Fig. 229 along with Figs. 227 and 228 for the description of the driving and the general working of the machine. The former view is shown on a larger scale so that the parts may be more easily followed. In Fig. 228 the engine bed is shown by the rectangular area 2, the crank and the fly-wheel at 3 and 4, and the two latter are also shown in Fig. 229. The desired speed of the main shaft 5 of the stenter is obtained by pinion 6 on crankshaft, wheel 7 on shaft 8, pinion 9 on shaft 8, and wheel 10 on shaft 5. A pulley 11 on shaft 8 drives the plaiting apparatus pulley 12 on shaft 13 by means of a belt 14. A second pulley on shaft 13 drives pulley 15 by means of a belt 16, while a small crank 17 on shaft or stud 18 connecting rod 19 and oscillating arm 20 complete the connection to the plaiting-down apparatus.

The direction of motion of the stenter shafts is indicated by the arrows in Fig. 229. The bevel wheel 20 on shaft 5 drives an upright shaft by means of bevel-wheel 21, while a larger bevel-wheel 22 on the upper end of the upright shaft drives shaft 23 by bevel-wheel 24. Situated on shaft 23 are two bevel-wheels 25 connected to the bosses 26. These bosses, and hence the wheels, are driven by shaft 23 by means of a sliding or float key, and the wheels 25 naturally drive bevel-wheels 27 in opposite directions Rising from the upper surfaces of wheels 27 are bosses 28, and upon these bosses are secured the sprocket wheels C (Fig. 228).

On the end of shaft 5 (Figs. 227 and 229) is a disc 29 which carries on its face near its periphery a pin 30. This pin controls connecting rod 31 connected to the lower end of lever 32 fulcrumed at 33. The upper end of lever 32 is connected to sliding block 34 on the end of shaft 23 by connecting-rod 35. A similar sliding block, marked $34^1$, supports the other end of shaft 23, and long slots in both frames are provided to admit of the necessary sliding action of blocks 34 and $34^1$. Referring now more particularly to Fig. 227, it will be clearly seen that as shaft 5 rotates, the pin 30 on

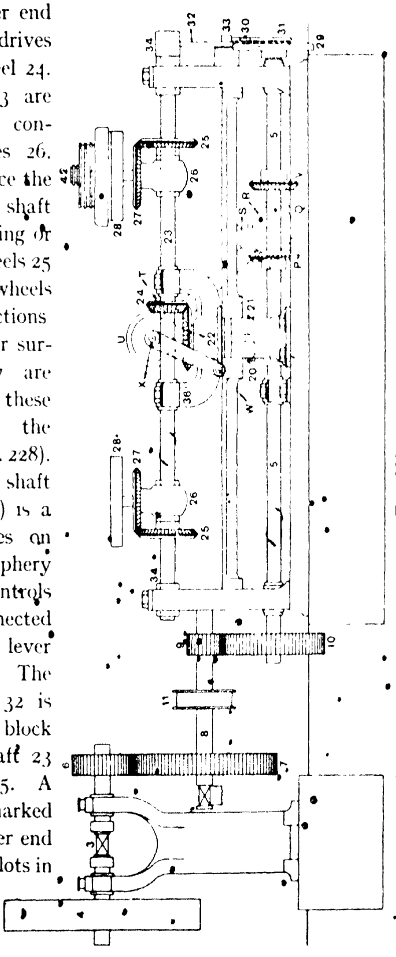


Fig. 229.

disc 29 and the other connections will cause blocks 34 and $34^1$ to move in their respective slots and in opposite directions, provided that shaft 23 is capable of being oscillated. The central supporting bracket 36 is loose on a central boss which also forms a support for the upright shaft upon which bevel-wheels 21 and 22 are fixed. It will thus be seen that the bracket 36 can oscillate, and it will be quite clear that if shaft 23 oscillates about the central boss, all parts on the shaft will also oscillate, and consequently sprocket wheels on bosses 28 and stenter rails A (Fig. 228), will move alternately backwards and forwards but in opposite directions. The extent of this movement is about 6in., and the object of the motion is to keep the threads and picks of the cloth in constant motion during the passage of the cloth through the stenter, and so prevent the threads and picks from sticking together during the process of drying. In stenters where the rails remain fixtures, so far as oscillation is concerned, the supporting columns 37 (Fig. 227), may be in one piece which reaches up to and supports the rails A and B. In jigging stenters, however, they are in two parts, the upper face 38 of the column 37 being planed and curved as shown in Fig. 228 (see also 35, Fig. 219). The ends of the cross-frames of the stenter are supported by separate parts 39 which carry pulleys or anti-friction rollers 40 as indicated in Fig. 227. During the operation of jigging, the rollers 40 move backwards and forwards on the curved, planed surfaces 38 of columns 37 through the action of the above-mentioned disc 29 and the connections to the rails. For ordinary stentering, the parts 37, 39, and 40 naturally remain stationary, and in every case the columns 37 have proper foundations 41.

A weft-straightening motion usually accompanies such machines. The mechanism of this motion is of a differential type, and it is situated immediately above one of the sprocket wheels C as indicated by the part 42 (Fig. 229). Its use is to enable the operator to alter the speed of the clip-chain under the weft-straightening motion 42 with respect to the clip-chain on the opposite rails. If the weft of the fabric is not at right angles to the threads of the warp, the above chain may be made to move slightly faster or slightly slower according as the weft on that side lags behind or leads that on the other side of the stenter. There are, of course, other types of mechanism for moving the stenter rails, but in all cases the principle of the movement with respect to the rails is the same.

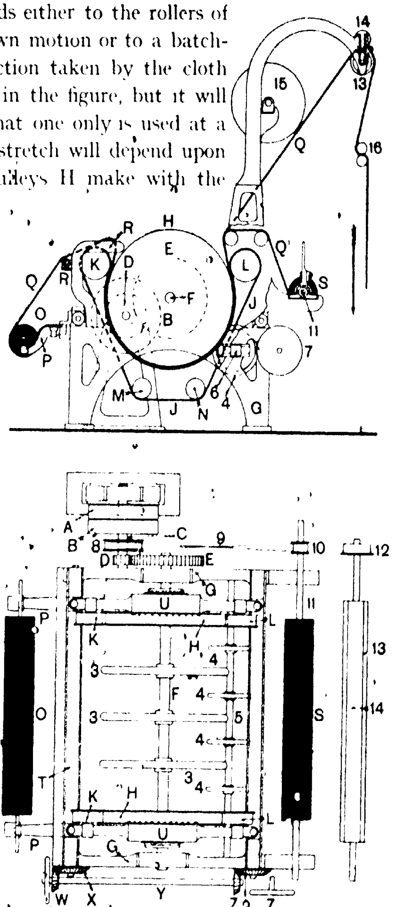
# CHAPTER XIX

## BELT STRETCHING, CALENDERING, CHASING AND BEETLING

THE finishing of fancy and figured goods generally differs from that of plain fabrics, although all kinds may pass through the same processes up to a certain stage—say that of the drying pans; several figured cloths, however, do not pass over the pans. When the length of cloth leaves the pans it is taken to the perching room and passed over rollers, so that the full length may be examined. This examination is usually done with the cloth falling, or perhaps drawn down mechanically by drawing rollers, between the examiner or percher and a well-lighted window; this is done so that the light may pass through the fabric and thus expose clearly any fault or damage which may be present at this stage. Each piece or cut of cloth is detached from the length after it has been examined and has emerged from the drawing rollers, but previous to this all damages are marked usually with a bit of Turkey-red cotton at the selvage, while after the cloths are separated all stained goods are put on one side for further treatment. The fancy goods are then taken to the stenter, and usually passed through singly as explained above, but the cotton and linen plain goods follow a different process. Similar widths of cloths of one type—*e.g.* cotton, linen, or union—are now selected and sewn together in a chain; this chain is passed through a damping machine somewhat similar to that illustrated in Figs. 15, 16 and 17, pp. 19 and 20. This particular machine damps both sides of the fabric at the same time, but in many cases it is considered quite sufficient for linen and cotton goods to damp one side only. After the cloth has been damped it may be taken to the belt-stretching machine or to the beetling machine. In order to avoid the trouble of damping, some pieces are removed from the pans in a more or less damp condition.

The object of the belt-stretching machine is to stretch the cloth from selvage to selvage in order to remove all creases and to increase the width. Two to four inches in width may be regained in this machine, the stretching apparatus of which is arranged to accommodate all widths of cloth from about 15in. to 90in. This machine is used for figured cloth, and extensively for plain fabrics.

All such machines are similar in construction, and that illustrated in Figs. 230 and 231 is made by Messrs J. H. Riley & Co., Ltd., Bury. The former view is partly sectional to show the path followed by the cloth, while the latter is a plan view of the main parts. The fast and loose pulleys are shown at A and B on the short shaft C. The fast pulley A transmits its motion to pinion D, which in turn drives wheel E on the end of the main shaft F. This main shaft is supported by bearings in the two end frames G, and near the inner sides of these frames are the two so-called belt pulleys H with flanged sides. These two pulleys H are set at an angle, that is, their edges are nearer to each other at the feed side of the machine than at the delivery side. Endless belts J, one on each side and about 4in. wide, shown solid black in Fig. 230, pass over these pulleys as well as over the upper and lower pulleys K, L, M, and N. Consequently the belts J run continuously when the driving belt is on the fast pulley B. The cloth to be stretched is brought on a wooden roller as shown at O, or else in loose folds, and placed at the feed side of the machine. When the cloth is on a wooden roller, the arbors of the roller are supported on swivel brackets P. The cloth Q is shown only in Fig. 230, and appears here as if it were a thread; this marking is adopted in order that the cloth may be easily distinguished from the solid black line which represents the belt. The cloth comes, as illustrated, from the entering batch or roller O, and passes over a suitable number of tension rails R—two only are shown in the figure—and is then guided between the belt J and the belt-stretcher pulley H, being gripped, of course, near the two selvages by the two pulleys. When the cloth enters as described it contains creases; but since the edges of pulleys H gradually widen out as they approach the delivery side of the machine, it follows that the cloth will be stretched, provided that no slip takes place. The faces of pulleys H are often covered with rubber or some such substance to increase the gripping power and thus prevent slip. Fig. 230 shows clearly that the cloth Q leaves the pulley H and the belt J at a point near pulley L, and the cloth from this point proceeds either to the rollers of an ordinary plaiting-down motion or to a batching roller S. The direction taken by the cloth is shown in both ways in the figure, but it will be clearly understood that one only is used at a time. The amount of stretch will depend upon the angle which the pulleys H make with the shaft F, and the adjustment for different degrees of stretch will be understood by reference to Fig. 231. A left- and right-hand screwed rod T passes through tapped parts in the ends of blocks U, so that when this rod is rotated the ends of the blocks and the edges of the pulleys H are moved nearer to or farther from each other. The adjustment is made by means of the hand-wheel V and bevel-wheels W and X, while the shaft Y, upon which V and W are fixed, is utilised to rotate similar parts on the other side of the machine through bevel-wheels Z and 2. In order, however, that the two sides may be moved independently of each other, if desired, clutches or catch boxes are provided on the shaft Y, but these are not shown on the drawing.



Figs 230 and 231

T

The cloth passes over the large pulleys or rings 3 in addition to the flanged pulleys H, while the smaller intermediate pulleys or rings 4 on shaft 5 serve to spread the stress over the full width of stretched cloth. The ends of shaft 5 are supported in blocks 6, which may be moved laterally by means of hand-wheel 7 in conjunction with suitable bevel-wheels, shafts, and screws in blocks 6. The intermediate pulleys 4 may be moved farther in or drawn out as desired to adjust the tension on the cloth.

On the main pulley shaft C is fixed a small pulley 8, and a belt 9 from this pulley drives a smaller pulley 10 when the cloth requires to be batched on the roller R. A long wooden box is placed on the spindle or spit 11, and the cloth is wound on this box; when the winding is finished, both box and cloth are removed from the spit. If the plaiting-down motion is to be used, the belt 9 (Fig. 231), is removed, and a different belt put on to the pulley 8 and over pulley 12 on the end of roller 13, roller 14 is, of course, the pressing roller. A further belt from pulley 12 drives pulley 15 on the crankshaft, the cranks operating the two small rollers 16 to obtain the well-known pendulum-like movement of the plaiter supports. The speed of the machine will depend to some extent on the fabric to be treated; a speed of 90revs. of the driving pulley B results in the delivery of 78yds. of cloth per minute, but in general the delivery is much less than this.

A further separation of the cloths takes place here; several plain and twilled fabrics go direct to the beetling machine, while figured fabrics, such as damasks, go to the calender. A 3-bowl calender is often used for fine goods. The heavy 5-bowl calender has already been described in pp. 23 to 26 while a 3-bowl calender, made by Messrs Mather and Platt, Ltd., Manchester, is illustrated in Fig. 232. This is introduced partly to show the type of machine which is used for linen and union fabrics in addition to cotton ones, and partly to illustrate a type of finishing which receives the name of "chasing." This finish imitates in a slight degree the beetle finish which is to follow, and is used principally for cotton, but also for unions. The cloth A' from the roller B' passes over and under tension rails C, D, and E, and then between the two bottom rollers F and G. It is then guided between the two upper rollers G and H, and conducted from the latter round the upper guide roller J to the lower adjustable guide roller K, and over a brass scrimp rail L, the face of which is grooved and corrugated. This grooved surface removes creases, and keeps the cloth out in width, so that it may pass under the bottom roller F and be delivered suitably stretched for a second time between rollers F and G, and also between rollers G and H. The cloth finally passes over the latter to be batched against it on to roller M, supported by arms N. A plaiting-down apparatus may be substituted for the batching roller if desired. The chilled-iron or brass centre bowl G is often heated by steam or by gas, while the larger rollers F and H are made of cotton or of paper, as described in connection with the similar paper bowls used in the 5-bowl calender. When a cloth passes singly between the bowls of the calender it is simply pressed, and its surfaces are therefore flat; but when two layers pass between as in chasing, the inner surfaces are pressed into each other, and the effect then is not flat, but is influenced by the particular

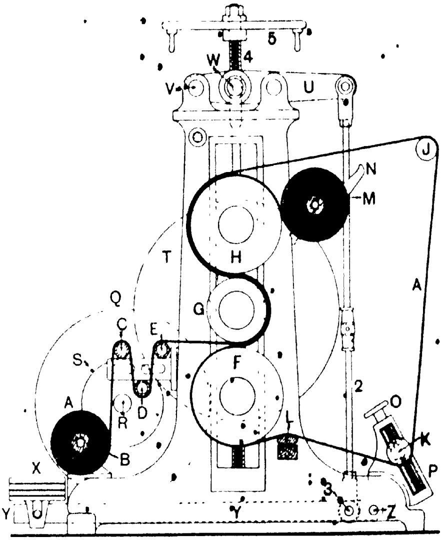


Fig. 232.

way in which the various parts of the two-layers cross or overlap each other. Sometimes the cloth is threaded through a third time in order to improve the effect. The wheel O in the adjustable slide P is for the purpose of raising or lowering the guide roller K, so that the cloth may be kept at the proper tension.

When this calender is used for damasks and similar linen goods, the cloth simply passes over the guide rails and singly between the bowls F, G, and H, the upper and lower ones usually being sycamore. Linen damasks are finished on what is termed the warp side—*i.e.* the side on which the ground is developed by the warp and the ornament by the weft; this side is in contact with the bowl G, which may be either hot or cold. On the other hand, mercerised cotton damasks and union damasks are finished on the weft side. Irish damask napkins are usually finished doubled, while Scotch napkins are finished full width. The calendering in these cases is evidently more simple than the operation of chasing.

The calender may have the usual fast and loose pulleys, or it may be driven by means of a friction clutch. Fig. 232 shows a machine arranged for the latter method of driving. A belt drives a belt pulley Q on shaft R, and on the same shaft is a pinion S which gears with wheel T on the end of the shaft of bowl G. A friction clutch, not shown, is placed on shaft R between the pinion S and belt pulley Q, and is operated by a handle and rods to place the machine in and out of action. The necessary amount of pressure is obtained by lever U, fulcrumed at V; the force is applied at W through the weights X on lever Y fulcrumed at Z, and an adjustable rod 2, which is attached at one end to lever U and at the other to point 3 in lever Y. The usual screw 4 and hand-wheel 5 are provided at each end for regulating the pressure on the blocks. Calenders such as this are often used to straighten and smooth out the cloth ready for the beetling machine.

BEETLING.—This is a very important process in the finishing of several kinds of linen and cotton goods, particularly of sheetings of various qualities. There are two distinct kinds of machines used for this work—the Wood Faller Beetle and the Spring Beetle. Each has its advocates, and there are certainly advantages which attend the use of either. The object of beetling is to fill up the cloth, or, in other words, to close up the small pin-like holes or interstices; to produce a high gloss on the fabric; and to impart the much-admired water-marks which help so much to beautify otherwise plain fabrics. Incidentally the operation of beetling increases the width of the cloth.

Considered in its simplest aspect, the beetling machine consists

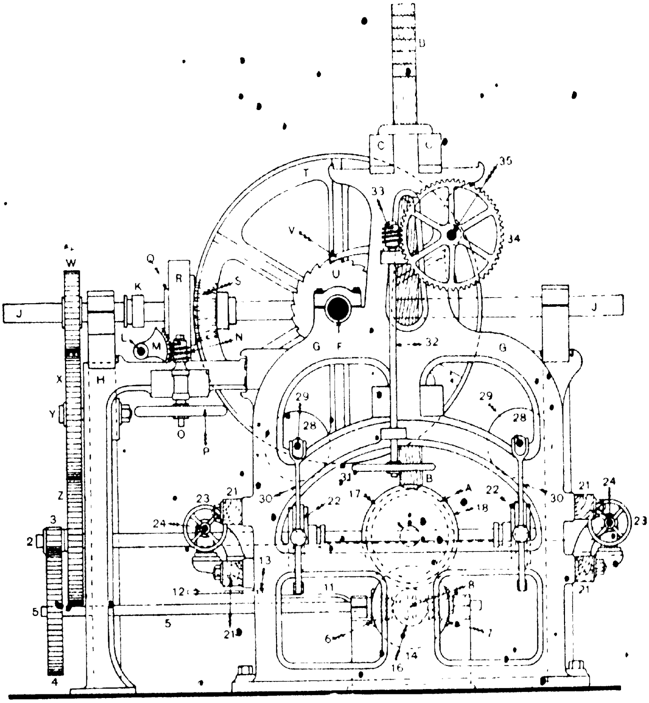


Fig. 233.

of a large roller or beam upon which the cloth is wound evenly and tightly. This cloth beam is made to rotate and also to move to and fro in an endwise direction; during these movements the ends of a series of heavy wooden beams, termed fallers or beetles, are allowed to drop successively on to the cloth, and thus spread out the threads without imparting the plain flat effect which results from calendering. Since there are several layers of cloth on the beam, the pressure or force imparted to the outer layer by the fallers is communicated to the inner layers, and the finish is therefore somewhat similar in this respect to those of chesting and mangling.

Large quantities of common goods are passed through a mangle —or, rather, a type of calender—preparatory to being beetled. This process helps to fill up the interstices between the threads and picks. After the cloth has been so treated, it is partially dried on the hot cylinders of the drying machine, or else dried perfectly on these cylinders; then re-damped, and finally taken to the beetling machine. In all cases the cloth must be in a damp condition before it is beetled, and it is a good plan, after having applied the moisture, to allow the cloth to remain a few hours so that the water may penetrate uniformly the various folds, and thus enable the cloth to be finished evenly. When the cloth has been damped and allowed to lie, as explained, for a few hours, it is considered to be in an ideal state for being beetled; the cloth is then termed "conditioned."

One of the best types of wood faller beetling machines, often termed "Lancashire beetles," is that made by Messrs Archibald Edmeston and Sons, Ltd., Patricroft, Manchester, and illustrated in Figs. 233 to 236. The above-mentioned cloth rollers or beams, which are about 19in. in diameter, are shown at A, and in Fig. 233 the first wood faller B is shown in its lowest position upon the cloth beam, and the latter, which carries the cloth, is naturally in the beetling position. The rest of the beetles are shown at different heights in the same figure, while in Fig. 234 the tops of 12 beetles are shown. In Fig. 236 two cloth beams A are shown, but neither of these is in the position for beetling; they occupy the present positions when the cloth is being wound on or wound off, termed respectively "winding-on" and "stripping."

Each faller B, of which there may be any number up to about 42, is 8ft. 6in. long, 4in. wide, and 5½in. deep, and is made from selected, well-seasoned beech. All the fallers are planed by machinery, machine-morticed, and are supported vertically by two iron guide rails C, which are also planed perfectly true in order that the up-and-down movements of the fallers may be performed smoothly and with a minimum amount of wear and tear. The planed surfaces enable the fallers to work vertically with very little clearance. Projecting from the face of each faller is a tappet D (Fig. 234), by means of which the faller is lifted to its highest position from the cloth bowl by a wiper E. There is a wiper for each faller, and all of them are keyed to the wiper shaft F; the latter extends across the machine, and rotates in brass steps supported in suitable bearings cast with and forming part of the massive end frames G. As the wiper shaft F rotates, each wiper comes into contact with and raises its own tappet D, and hence its faller B, to the highest position. The wipers themselves are set to form spirals round the beam so that they act successively. They are set in groups of about nine, and hence there will be two, three, or four fallers at the same height, according as there are 18, 27, or 36 fallers. The path described by the tops of the fallers is more or less of a wave-like character. Each wiper is withdrawn from contact with the tappet D as the point of the wiper is approaching the top centre, and hence, when this occurs, the faller drops in virtue of gravitational force and imparts the desired blow to the cloth on the beam A. Although it is absolutely essential that the faller should descend rapidly, it is equally essential, or at least desirable, that it should

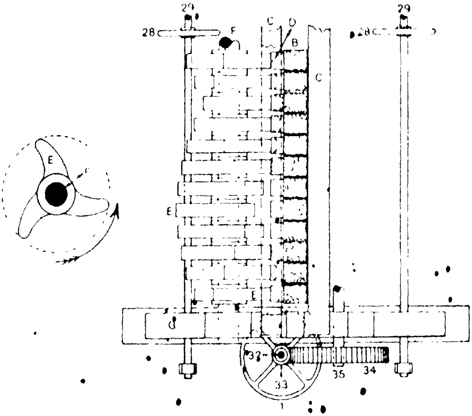


Fig. 234.

be raised slowly, particularly during the first part of its movement. The wipers are designed specially to impart this valuable movement, for the lower part of the tappet D first comes in contact with the wiper as near as possible to the centre of rotation. The inertia of the faller is consequently overcome by a minimum of wear and tear, for the upward movement of the faller is comparatively slow at first, but increases gradually until the wiper leaves the tappet.

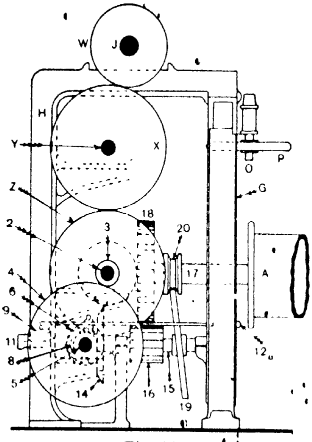


Fig. 235.

The general principles of beetling being now understood, we may proceed to describe the remaining parts of the machine. A particular feature of this beetle is that all the gearing is supported independently of the walls of the building: this precaution, although no doubt, and naturally, increasing the cost, eliminates the vibrations which usually undermine the stability of the wall. The gearing is contained between the frame G of the beetle proper and the supplementary frame H. The latter is bolted to the substantial foundation and to the frame G. The main driving shaft J extends from the front to the back of the machine, and is placed in and out of action by a patent friction clutch which acts quickly and efficiently. The clutch sleeve itself is shown at K, but the fork which operates the sleeve is omitted. This fork is secured to the sleeve K in the usual way, and also to the shaft L. The toothed quadrant M is also secured to the shaft L, and is operated by the worm N on the short vertical shaft O. All these parts are moved by rotating the hand-wheel P. When the clutch sleeve K is caused to slide along the shaft J, the inner grip ring Q makes connection with the outer part R of the clutch, and thus imparts motion to the wiper shaft F through the large bevel-wheel T and the small bevel-wheel S, mounted on the boss of the clutch ring R. Immediately behind the large bevel-wheel T is a ratchet wheel U and a pawl V to be brought into use when the fallers are lifted manually.

On the end of the main shaft J is fixed a wheel W, which, through intermediate wheel X on stud Y, conveys the motion to wheel Z on shaft 2. Alongside wheel Z on same shaft 2 is a pinion 3, which drives wheel 4 on the low shaft 5. On the low shaft 5, and opposite the central line of the frames G of the beetle, are two catch-box bevel-wheels 6 and 7, and either of these may be put in motion by the catch-box or clutch 8 in the usual way. When the clutch 8 is centrally situated, as illustrated in Fig. 236, it is out of gear with both wheels 6 and 7. It may, however, be slid on the shaft 5 by means of the lever 9, fulcrumed at 10, connecting-rod 11, and hand-lever 12 fulcrumed at 13, and so placed in gear with either wheel 6 or wheel 7. In either case the larger bevel-wheel 14 will be rotated, the direction of rotation depending upon which wheel is in gear with bevel-wheel 14. As a natural consequence, shaft 15 and broad-toothed pinion 16 can be rotated in either direction at will.

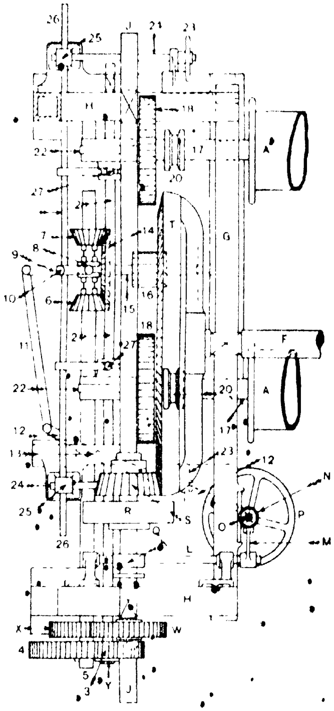


Fig 236.

The shafts 17, of both cloth rollers A are prolonged as shown, and each shaft carries near its end a wheel 18. The object of this wheel is to gear with pinion 16 when the cloth beam is in the beetling position—*i.e.* immediately under the fallers B as shown in Figs. 233 and 235. A cam 19, shown only in Fig. 235, is secured to the shaft 15, and runs in the grooved pulley 20 when the cloth beam is under the fallers B. Wooden tension rails 21 (Fig. 233), are provided on both sides of the machine, and by means of these rails the cloth is kept taut as it is guided on to the cloth beams A. The cloth beam occupies one of the positions indicated in Fig. 236 for the winding-on operation, and also for the stripping operation which is naturally performed after the cloth has been beetled sufficiently, or after it has been partially beetled to turn it end for end, and thus allow that end of the cloth which was next the beam to occupy the outside position ; this gives all parts the same or as near as possible the same amount of work. It is essential, as already stated, that the cloth should be absolutely free from creases on the beam, or otherwise unsatisfactory work, and probably cut cloth, will result. Consequently, great care should be exercised when the cloth is being wound on to the beam A. For filling and stripping, the cloth beam is driven by compressed paper friction pulleys 22 on the shaft 2. These pulleys are placed in and out of gear by hand-wheel 23, shaft 24, pinion 25, racks on shaft 26, and parts 27. Hand-wheels 28 on rod 29 and levers 30 are utilised to apply the necessary pressure for driving the beams efficiently for filling and for stripping.

When the cloth beam has a thickness of 1in. to 1½in. of cloth wound upon it, the whole is ready for being transported under the wooden fallers B. This is done by the aid of a pinch bar and a long rack cast on the outside of the frames G. In order to obtain room for the free entry of the beam under the fallers B, and also to facilitate its removal after the piece has been beetled, the fallers B may be raised sufficiently high by the hand-wheel 31, rod 32, worm 33, and wheel 34 on shaft 35. On shaft 35 are fixed two sprocket wheels, and chains from these wheels support a long bar, which, when in its lowest position, is below a series of pins—one from each of the fallers B. Thus, when the shaft 35 is rotated by hand-wheel 31 and other parts, the long bar is raised ; as the bar ascends it arrests the pins and carries them and the fallers clear of the beam. The pawl V is allowed to fall into contact with the ratchet wheel U at this time. In addition to the combined movement of the fallers by the bar, any single faller may be held up while the others are in operation.

Two or more pieces in width may be wound on the cloth beam A, depending naturally upon the width of the pieces. Whenever this is the case, it is necessary to leave sufficient space between the selvages of the adjoining pieces to allow for the increase in width due to beetling. It is often necessary to hold up that faller which is immediately above the gap between the pieces. If the cloths widen sufficiently, the faller may be liberated and thus work in conjunction with the others.

From the description of the principal parts it will be evident that when the shaft J is rotated, the following trains of wheels will be set in motion :

1. The wiper shaft F, through bevel pinion S and bevel-wheel T. The wipers E will therefore commence to lift the fallers B successively, one from each group at a time, and each faller imparts 70 blows per minute.

2. The middle shaft 2 upon which the compressed paper pulleys 22 are fixed, which drive the cloth beams A for winding-on and stripping, provided they are placed in action by the hand-wheel 23 and intermediate parts.

3. The low shaft 5, which carries the small bevel-wheels 6 and 7 for driving the short shaft 15 in the desired direction by the clutch 8 and wheel 14, while at the same time the broad pinion 16 on shaft 15 drives the wheel 18 and therefore the cloth beam A ; the cam 19, through grooved pulleys 20, imparts the necessary endlong movement to the cloth beam.

After the cloth beam has run for a suitable period in one direction, say, with bevel-wheel 6 in gear with catch-box 8 and bevel-wheel 14, the two former are disconnected, and the catch-box placed in gear with bevel-wheel 7, which results in the bevel-wheel 14, and therefore the cloth beam, being rotated in the opposite direction. Whichever direction the cloth beam rotates, it is also moved slowly from side to side as stated.

We have already said that it is necessary for the cloth to be free from folds and creases, and in order to secure this, the cloth is often stretched by the stenter, or else by the belt-stretching machine, before it is wound carefully and tightly on to the beetling cloth beam. It is a common practice to have two wide cloths, say 72in. each, in the width of the beam, and several pieces on each width. The main shaft J runs at about 110 revs. per minute, and the cloth beam at 4 to 5revs. per minute, while its endwise movement is usually about 4in.

Figs. 237 to 239 illustrate the spring beetle as made by Messrs Mather & Platt, Ltd., Manchester. It is naturally designed to do the same kind of work as the wood faller beetle, but very much quicker. Fig. 237 is an elevation of the feed side of the beetle, Fig. 238 an elevation of the end with all the gearing, and Fig. 239 an elevation of the opposite end but of a right-hand machine. The drive is usually taken from some main shaft in the finishing department to both sets of fast and loose pulleys A and B on the main shaft C of the beetle. On shaft C are fixed several eccentrics D, each one being a certain number of degrees farther round in order that they may act upon the beetle hammers E at different times and in regular succession: one of these eccentrics is shown in its lowest position in Fig. 239. By this arrangement the hammers, a special view of which will appear later, act very much in the same way as the wood fallers in the Lancashire beetle.

There are three cloth beams (F, G, and H) in this machine, and these beams are rotated upon the central shaft J in a similar manner to the "pins" in the hydraulic mangle see pp. 48 to 72. The arbors of the beams F, G, and H (Fig. 239), are supported 120° apart by the discs K, and the beam F is obviously in the beetling position. When the machines are erected it is usual to give each beam two or three good coats of white lead-paint, and when the paint is dry to cover the beams with cloth; this is done to prevent stains from rust and other sources.

The actual beetling operation has already been described, so that little more need be said in connection with this part of the work. It should, however, be pointed out that the character of the blow from a spring beetle is somewhat different from the blow imparted by a falling wooden beetle, since the former is more flexible. The beam, which for the time being is under the hammers of the beetle, has a to-and-fro motion in addition to a rotary motion. On the end of shaft C is a pulley L, and a crossed belt M passes over this pulley as well as over pulley N on the short shaft O. A worm P on the shaft O drives a worm-wheel Q on the vertical shaft R, while a second worm S on the shaft R drives a worm-wheel T on the short shaft U. A heavily shrouded wheel V on the shaft U finally drives the wheel W, and hence the cloth beam F. This mechanism clearly imparts the rotary motion to the beam under the beetles. The endwise movement of the same beam is obtained by means of the anti-friction bowl X and the grooved cam Y; the anti-friction bowl rotates on a fixed stud, and the grooved cam is compounded with the shrouded wheel V. Both the grooved cam

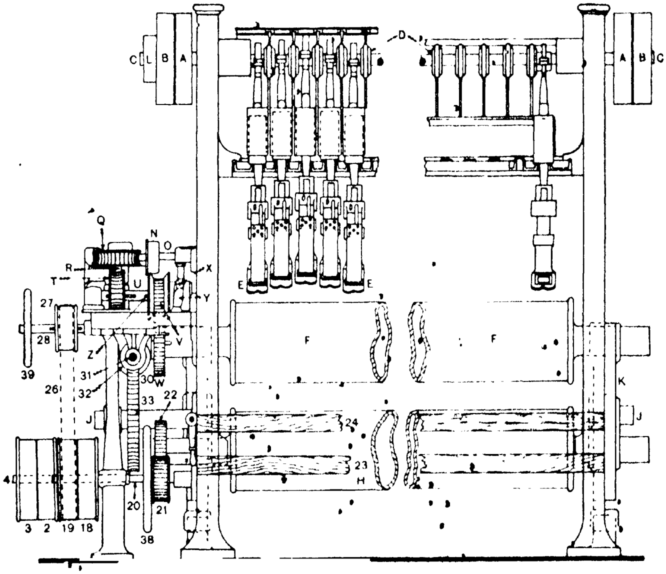


Fig. 237.

and the shrouded wheel are capable of sliding on their shaft U by means of the usual sliding key and keyway Z. The heavy shrouding on the wheel V draws the wheel W, and therefore the beam F, to and fro in the usual manner.

The beam G is in the stripping position, and the beam H is in the beaming position. Two sets of fast and loose pulleys are provided for the beaming and stripping motions, and these are usually driven by means of a crossed belt and an open belt from pulleys situated on a supplementary shaft. The latter shaft is most conveniently placed a little above the pulleys A and B on the left of Fig. 237, and driven from the main shaft of the finishing department. The open and crossed belts are necessary in order to drive the cloth beams in opposite directions, according as the cloth is being wound on or wound off—*i.e.* beaming or stripping.

We might imagine that the cloth on the beam F is being beetled ;

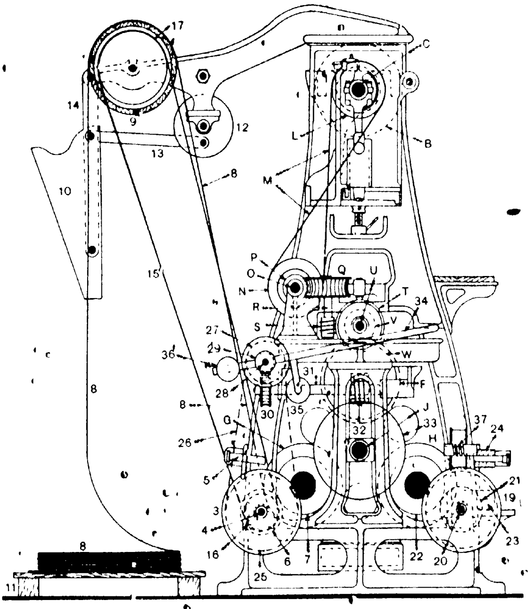


Fig. 238.

that the cloth on the beam G is ready for being stripped ; and that the cloth beam H is empty. Fast and loose pulleys 2 and 3 on the short shaft 4 are operated by the usual belt fork 5 at the stripping side of the machine ; on the same shaft 4 is a spur pinion 6 (Fig. 238), which gears with and drives wheel 7, and ultimately, by friction cone pulleys, the cloth beam when all is ready for stripping. The cloth 8 is taken over the winch 9, then through the plaiting-box 10, and ultimately deposited in the well-known plaited or folded form on the stillage 11. The plaiting-down apparatus is driven from the disc 12 by connecting-rod 13 and oscillating arm 14. The winch 9 is driven by the belt 15 and pulleys 16 and 17.

Fast and loose pulleys 18 and 19 on shaft 20 (Figs. 237 and 238), on the beaming or feed side of the machine, are arranged in a similar manner to drive the cloth beam H through wheels 21 and 22 and friction cones not shown. The cloth is tensioned in the usual manner by passing it under and over rails 23 and 24, and over the empty beam. The outer cone of the friction drive is then placed in contact with the inner cone, and the beam H rotated until the cloth is tightly and evenly wound on. When the stripping and beaming operations are concluded, and when the cloth on beam F has been beetled sufficiently, all is ready for the rotation of the discs K on shaft J. The spring hammers, which happen to be in or near their lowest positions, are raised by the cloth as the latter is approaching the beetling position, while the discs K are rotated by means of the following mechanism: Alongside the pulleys 2 and 3, and on the same shaft 4, is a third pulley 25, and a loose belt 26 connects this pulley with the pulley 27 on shaft 28. A worm 29 on the shaft 28 drives worm-wheel 30 on the shaft 31; a second worm 32 on the shaft 31 gears with wheel 33. By pressing down gallows pulley lever 34, the pulley 35 is pressed against and draws tight the belt 26, in which case parts 27 to 33 are set slowly in motion. The action is kept under complete control of the attendant, and when the discs K have rotated one-third of a revolution, the handle 34 is released and returned to its inoperative position by weight 36. A set-pin 37, which passes through the frame, is then caused to enter a hole on the outer circumference of one of the discs to keep the discs and the three cloth beams in their proper positions. The necessary hand-wheels 38 and 39 are provided for manual adjustments, while the handle 40 (Fig. 239), together with rod 41, shaft 42, and belt fork 43, provide means for starting and stopping the eccentric shaft C.

Figs. 240 and 241 are respectively a side elevation and a front elevation of the complete patent spring beetle as usually supplied with the above machine. It consists of the two steel springs A fixed in the iron headpiece B. These springs are about ⅜in. thick near B, but gradually taper to about ⅛in. at the curved ends. The lower end C of the headpiece is encircled by the upper part D of the beetle itself, while the lower face E of this beetle comes in contact with the roll of cloth on one or other of the beams F, G, or H in Figs. 237 to 239. Four lengths of ¼in. leather belting F, about 4in. wide, pass through a hole near the lower face of the beetle, and the centres of these lengths are fixed securely to the beetle by means of an iron plate G and suitable keys H. The ends of the leather belts are then riveted to the two rods J, one end of each rod being flattened at K to admit of a neat and secure grip, while the other end of each rod is screwed. The rods are then passed through holes in the headpiece B, and nuts L screwed on. One complete beetle and holder is then secured to each plunger rod M by means of the flat pin N.

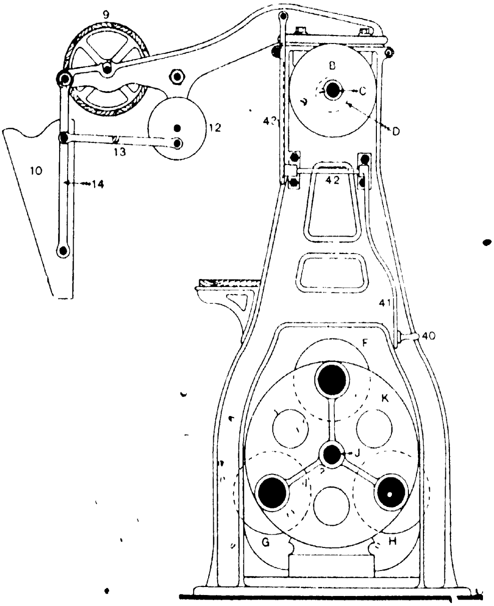


Fig. 239.

Before beetling commences for the first time, the nuts L are tightened until the proper degree of tension has been imparted to the belting F and the springs A. It will be quite evident that, since the circular part C can slide in D in addition to the up-and-down movement imparted to it by its own eccentric on the main

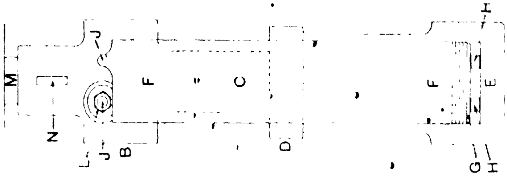


Fig. 241

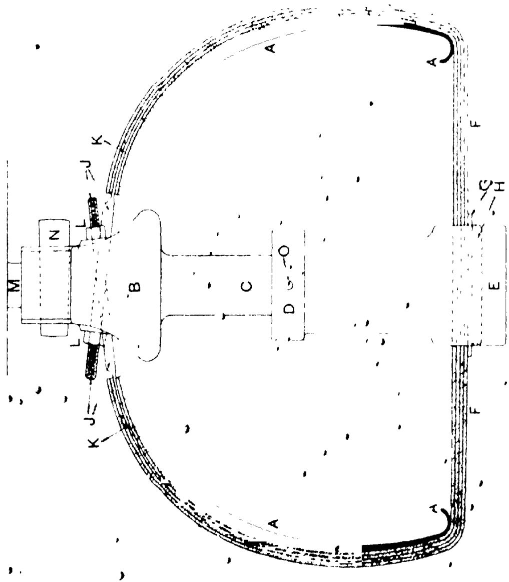


Fig. 240

shaft, the blow given by the face E of the beetle is more or less elastic, and does not therefore damage the cloth. Of course, it will be understood that a positively driven beetle would be quite unsuitable for the work, and hence the necessity for constructing the beetles with some yielding or flexible connections. With constant work the belting F stretches, but more particularly when it is new; the belting, as a whole, has then to be adjusted by means of the rods J and the nuts L. Some beetles are made with two sets of flexible couplings.

Any beetle which for the time being is required to be inoperative can be placed out of action by raising the lower part D E and inserting a pin into the hole O. All the beetles may be raised or lowered bodily to modify the stroke, or rather to maintain a uniform blow for different diameters of cloth and beam combined, and also to regulate the force of the blow for different fabrics. A graduated scale is fixed to the framework, and a pointer, which moves with the blocks, indicates the extent of movement in either direction, and serves to obtain accurate adjustments. It is a common practice in some finishing departments to paint two or three white rings on each side of each cloth beam, in order that the cloth may be beamed on the most convenient positions according to the widths of the cloths. The usual cloth guides are provided on the tension rails.

The time during which the cloth is under the beetles varies considerably, not only on account of the type of machine used, but also according to the class of cloth in process and the degree of finish desired For some classes of plain heavy linen fabrics not more than 10 to 15mins. are allowed in the spring beetle, and this or any other time or number of revolutions may be indicated by a clock. On the other hand, a much longer time would naturally be allowed for the same class of cloth in the wood-faller beetle. Again, with fine linen goods there is a great difference in the time allowed, for whereas in some districts the fabrics are under the action of the wood-faller beetles for from 48 to 60 hours, in other districts, and with precisely the same type of beetles, the process is continued only for from 10 to 12 hours. In both cases the cloths may be turned several times during the operation. The time is determined, not only by the class of fabric, but also by the weight of the fallers, by the number of blows per minute, and by the degree of finish which is desired.

After the beetling process, and particularly for fine linen goods, the cloths are examined and then sewn end to end for the calenders.

1. The cloths are usually run through a 5-bowl calender fitted with iron, cotton, iron, cotton, and iron bowls respectively.
2. Cloths examined for damages and stains.
3. Cloths crisped and run through calender once or twice.

A 3-bowl calender is often used for fine goods.

After the last finishing touches, the material, if in piece form, is then made up into rolls or other forms and parcelled up ready for despatch. When the pieces are intended for cloths, sheets or other forms which necessitate cutting, this operation, as well as any subsequent operations such as those described in the next chapter, is naturally done before the articles are finally finished. The making up of the cloths is then performed, and this usually consists of placing a convenient number into each parcel. This number naturally varies according to the size of the article and to the requirements of the various merchants.

# CHAPTER XX

## ORNAMENTATION BY HEMSTITCHING, EMBROIDERY, AND SIMILAR MECHANICAL OPERATIONS

THE foregoing processes may be considered as the final mechanical finishing operations, and were indeed the real final processes a little more than two decades ago. The increasing tendency which prevailed about this period for adorning many kinds of linen and other fabrics with fancy needle-work of various types led to the introduction of mechanical means for the embellishment of such goods with similar patterns. This extension of the trade has gradually developed until at the present time it has assumed huge dimensions. Our shops now display table cloths, table covers, table napkins, table centres, bed spreads, furniture covers, sideboard covers, duchesse covers, bed sheets, pillows, bolsters, various kinds of ladies' dress goods, doylies, tea cloths, tea cosies, handkerchiefs, and several other types of household linen, either with one or more rows of hem-stitched work, drawn-thread work, or embroidery displayed at suitable parts of the articles. At first sight much of this ornamental work appears far too elaborate and intricate for anything but prolonged and tedious hand work, but the skill of the engineers has enabled machines to be introduced which perform wonders in such delicate ornamentation. Of course, it must be understood that the personal element pervades largely, for although the machines are capable of imparting the proper stitch and pattern, it is evident that the operative must see that the article synchronises with the movements of the various parts of the machine, and where the character of the stitch varies incessantly, the attendant must naturally attend to and move the lever which causes the delicate mechanism to make such alteration.

This valuable departure in mechanical ingenuity has been the means of placing within the reach of most persons the opportunity

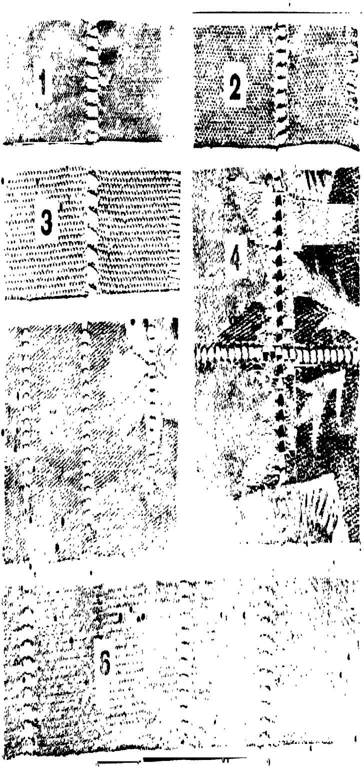


Fig. 242.

of securing these ornamental articles at a price which in many cases does not differ sensibly from that which obtains for the plain article.

Such a work as this would certainly be incomplete if it neglected entirely this important branch of the linen industry. It is, of course, impossible to illustrate every or even a small fraction of the various types of ornament, but we shall endeavour to show sufficient in the concluding stages of this volume to emphasise the importance of this branch, and at the same time to describe briefly the routine which the cloths follow from the time they enter this supplementary finishing department to the time when they are parcelled up ready for despatch to the distributors or to the retail dealers.

One of the simplest branches in this supplementary finishing department is the preparation of the small and medium circular or other central parts of dish covers and tray cloths. The cloths for these centres are usually comparatively fine damasks, the pattern may be a simple small hailstone spot or some similar small effect, or the cloth may be ornamented by some complete damask pattern suitable for the size and shape of the centre. If a special and complete pattern appears on the cloth, it is clear that care should be exercised when cutting out the circular or other shaped part; if, however, the patterns are small and oft repeated, no such care is necessary.

Several layers of cloth are placed in a pile, and the whole put under a heavy press somewhat similar to but heavier than the ordinary copying-presses. Different-sized circular cutting dies are provided, and the proper sized die placed centrally on the top of the cloths under the press in order that all may be cut together when the upper plate of the press is screwed down. Each circular piece of cloth is then whipped or over-edged all round in a special over-lock sewing machine, and the finished article is then ready for being adorned by suitable crochet patterns.

Hemstitching of various types forms a very important and extensive branch in the finishing of various linen articles. Napkins and table cloths for hemstitching are first carefully doubled near the edges to form the hemstitched border; the corners are then sewn, small parts clipped off so as to leave from ¼in. to ⅜in. on each side of the sewing, and then the corners are turned in and neatly shaped at right angles by means of a pointed piece of hard wood. The sewn edges or corners are then beaten to make them lie flat.

There are several types of hemstitch, and a few are illustrated in Fig. 242. Patterns 1, 2, and 3 show different weights and setts of linen cloth with the same width of stitch; the small fringes near the edges emphasise the difference in sett. Before these cloths are hemstitched, a certain number of threads or picks are withdrawn to make the opening the desired width; and this opening is sufficiently far from the edge to allow the length of cloth to form the doubled portion. Pattern 4 is a damask pattern with hemstitching in both directions, while pattern 6 is a huckaback towel with border and fringe and three lines of hem-stitching. In these five examples the threads and picks were withdrawn. The work of withdrawing the picks is very tedious, especially in fine cloths, and on the whole it is a lengthy process. Wires and cords have been woven into the cloths in the way of the weft at the proper distance apart, and afterwards withdrawn to leave a gap or shire, and thus dispense with the necessity for pulling out the picks; for the same purpose the cloth has been drawn forward in the loom to leave a gap or shire. Neither method is really a success, at least so far as the writer's experience goes. Even for gaps in the way of the warp, the omission of one or more splits of warp in the reed is scarcely satisfactory, for during the bleaching and finishing process the threads near the gaps have a tendency to move laterally.

The necessity for withdrawing picks or threads for narrow openings has been obviated by the introduction of what is termed an auxiliary piercer. The hemstitch formed by the addition of this extra piercer is illustrated at 5 (Fig. 242). It will be seen that the cloth is intact near the bottom of the sample where the hemstitching stops, thus proving that no threads have been withdrawn. In one type of machine, made by The Singer Manufacturing Co., Ltd., there are two piercers in addition to the two needles. The first piercer, termed the auxiliary piercer, forces a hole in the cloth a little in advance of the stitching; then the cloth is carried forward a little, when the second piercer enters the hole already made by the auxiliary piercer, while the latter is simultaneously making another hole, and so the process is repeated. The second piercer keeps the opening wide while the stitching is accomplished. A ingle piercer is also used for those cloths where the threads or picks ave been withdrawn, but in this case the sole object of the piercer s to divide the threads or picks which bridge the gap into groups o that the hemstitching may be performed satisfactorily. The poke stitch is somewhat similarly made, but the spear is much arger than the piercers; it simply opens the spaces for the stitches to bind both sides of the openings neatly. There is also the single-stitch hemstitch done with one needle, but most of this work is now done with two needles.

The hemstitching machines may be made with forward feed, or with forward and return feed. In the former case the stitches, although moving to right and to left as well as straight, are always proceeding forward. In the return stitch, however, the stitches are somewhat similar to those illustrated in Fig. 243. The stippled parts in this figure represent the cloth on each side of the shire or gap; the horizontal lines between the stippled parts represent the groups of threads which are collected in the work; while the two rows of stitching are between the threads and cloth, or on the cloth. It will be observed that the feed is as follows:—

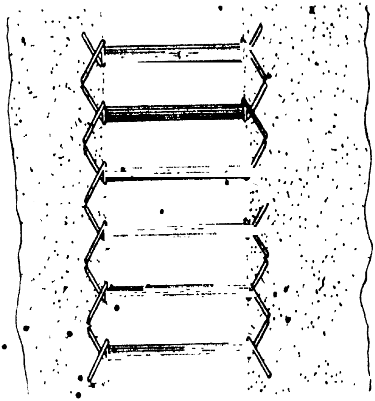


Fig. 243.

One stitch forward
,, ,, backward } repeat,
,, ,, forward

the backward motion giving the straight stitch, while the two forward motions impart the zigzag stitch; the needles move laterally to obtain this zigzag effect.

When the hemstitch is in the form of circles, festoons, or of a curved form generally, a vibrating pressure foot is fitted; this pressure foot is arranged to lift automatically from the cloth at each movement of the feed. The cloth is thus liberated for a fraction of a moment, and thus allows the operator to turn the cloth in the desired direction according to the outline of the ornament.

For more elaborate work, such as one sees on several types of ladies' handkerchiefs, there may be the ordinary straight or figured hemstitched border, as well as a double row of hemstitching on the cambric itself within the hemstitch border. In others, tucks may be made at the same time as the machine is hemstitching; plaiters are naturally provided, when tucks are required. Insertion work may also be sewn on and the hemstitch formed at one operation.

Fig. 244 illustrates a more elaborate type of hemstitching than those illustrated in Fig. 242. The cloth has three rows of hemstitching—two single rows and one double row. In addition there is a plait on each edge.

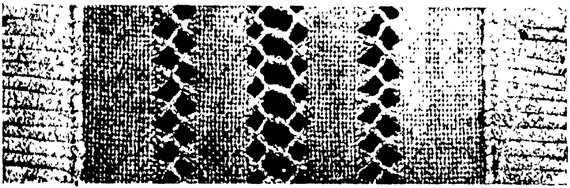


Fig. 244.

Fig. 245 illustrates four patterns of a different type. In these cases a thick cord or the like is displayed in sinuous or other forms on the surface of the fabric, and at the same time the cord is stitched to the fabric. One or more spreaders are used in conjunction with the needles. Such ornamentation is often applied to collars and wristbands for ladies' blouses.

Another exceedingly popular and beautiful type of ornamentation is the scallop, two examples of which appear in Fig. 246. Behind each machine is a small grooved cam, and this cam communicates its movement to two feed rollers near the stitching mechanism. The rollers grip the cloth, and as they rotate, the cloth is fed into the machine. The lateral movement imparted by the cam to the rollers causes the latter to carry the cloth to right and to left alternately. The lateral movement of the cloth, combined with the forward movement, gives the well-known festoon ornament or scallop. Different forms of scallops may be made by varying the

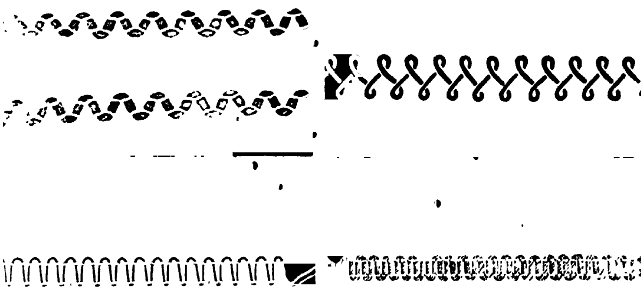


Fig. 245.

relative speeds of the above two movements perpendicular to each other, while other similar but more elaborate ornamentation may

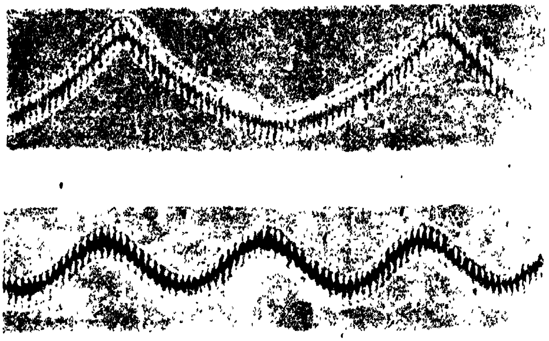


Fig 246.

be obtained by the proper construction of cams. After the scallop has been stitched all round the cloth, the edge outside the scalloped border is deftly cut out by young girls with the aid of hand-scissors.

These cloths are naturally much creased when they leave the machines, and have in consequence to be laundered separately by hand. The raised scalloped patterns make them unsuitable for any type of calender finish.

Fancy designs of all kinds are also displayed by a system of sewing on to linen goods. Originally the desired pattern was transferred from specially prepared paper on to the cloth by means of a hot iron. The patterns are now prepared on oil-paper by a special machine. The whole of the outline of the design is perforated on to this oil paper by a needle. Then this perforated paper is placed over the stretched cloth, and the pattern stencilled by rubbing a flexible material, usually rubber, covered with starch, over the small holes. The outline of the pattern on the cloth then appears in the form of small blue dots.

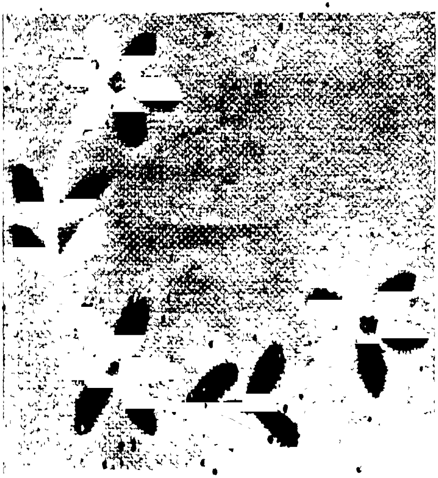


Fig. 247.

Suppose the pattern to be sewn on was that illustrated in Fig. 247 (which, by the way, is in two colours). The widest distance to be stitched in this pattern is about $\frac{3}{16}$in. The needle is made to bridge the gap between the two lines enclosing a figure, providing that distance is not greater than $\frac{1}{4}$in. This is the limit of the movement; but this, or anything shorter than this—and it is usually considered advisable to keep within the maximum limit of the stitch—can be obtained with the machine running at full speed This varied movement of the needle is under the complete control of the operator. She keeps her eye on the pattern near the needle to see how far the needle should travel between the two lines on the design, and controls the lateral movement of the needle by pressing in, with her knee, the knee lever A (Fig. 248). The degree of accuracy, and the correctness of the stitch between the two outer lines of any part of the ornament, naturally depend upon the skill of the operator in moving the knee lever, but once she is accustomed to the machine, it becomes an easy matter for her to regulate the width of stitch very correctly.

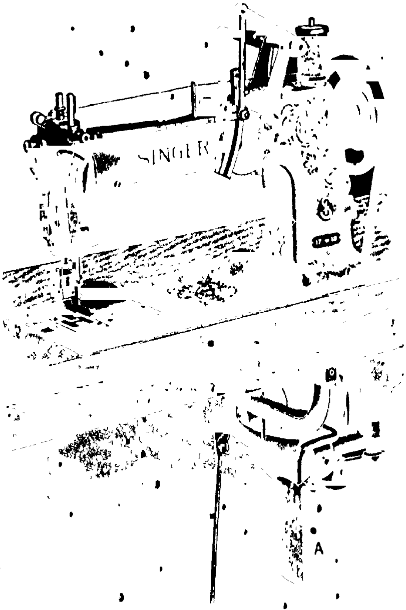


Fig. 248.

Another method by means of which any type of ornament may be embroidered on to a number of different cloths at the same time is that illustrated in Fig. 249. A number of sewing machines, six in this view, are driven simultaneously from a small motor by a chain, or by other suitable mechanism. Each machine is provided with a large and a small spring ring or hoop, and either may be used to accommodate different areas of ornament and to keep the part which is to be embroidered stretched tightly. Each ring is fixed to a horizontal bar which extends the full length of the table, and since all the rings may be adjusted in two ways, at right angles, they can be placed so that the design may be introduced at the correct place relative to the woven ornament on the cloth. The long bar is counterpoised by weights in order that the bar and the rings may be moved freely in any direction, and the whole is operated by means of a pantograph: hence, the machine is termed the "pantograph embroidery machine."

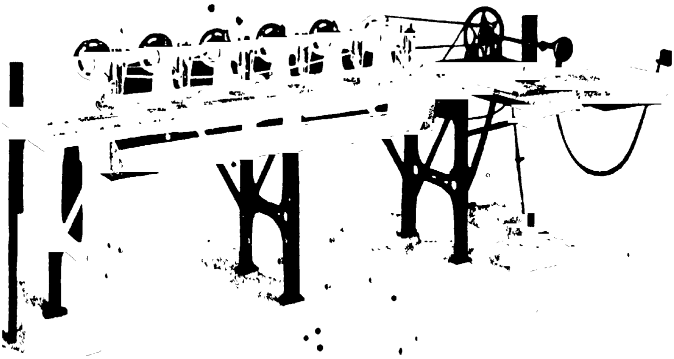


Fig. 249.

Fig. 250 illustrates one kind of work which is often done, and indeed which has been done on this machine made by the Singer Manufacturing Co., Ltd. The monogram, or other design, is placed on the projecting table on the right where the operator has complete command of the treadle and the pantograph. The design is always larger than the embroidered reproduction, and the operator moves the indicator of the pantograph across the various parts of the design, and in virtue of the long bar being attached to the pantograph, the rings move in precisely the same direction as the indicator but through less space. Thus the design is embroidered on to each of the six articles.

The thread from each machine controls its own particular wire which drops on to a plate when the thread breaks: the electrical contact thus made between the wire and the plate causes a bell to ring to warn the attendant of the broken thread. It will be understood that some such arrangement is necessary, because the operative must keep her eyes constantly upon the design for the sake of getting the correct movement of the indicator. In addition to this, she has naturally to get accustomed to the varying sounds of the machine so that she may move the indicator and rings only when the needles are above the cloths. Parts are sometimes added to prevent the rings from moving should this function be tried while the needles are through the cloth.

Fig 259

The pantograph has been used in connection with other branches of the trade also for a reducing instrument, but it is exactly on the same principle as that illustrated on page 189, *Textile Design, Pure and Applied*, in which the instrument was described for the purposes of enlarging a design.

This brief description of the work performed by the above-mentioned sewing machines, together with the more detailed description of the machines used for ordinary sewing purposes, serves to demonstrate the great importance of mechanical sewing. And it must be remembered that we have dealt only with machines which are used extensively for sewing jute and linen fabrics, and have not by any means exhausted those used for this purpose.

Figs. 251 and 252.

Perhaps at some future date, if time and opportunities are available, this particular subject will be more thoroughly treated.

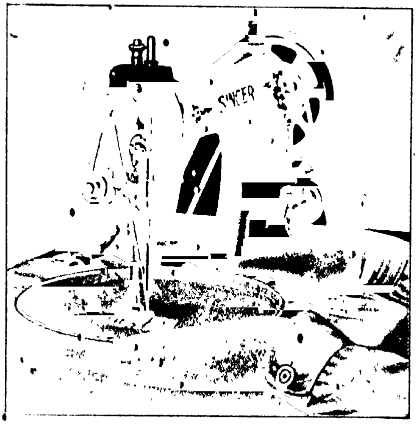


Fig. 253

We may say, in concluding this work, that there is scarcely any kind of sewing, plain or fancy, which cannot now be done by machines to make textures into suitable articles, or to embellish otherwise plain articles. And even when the material of which these articles or fabrics are made begins to show signs of wear, or to exhibit holes, the machinist still presents his wares in the form of mechanism which darns up the holes. Particularly is this the case with table damasks, sheets, etc., but also with coarser articles, literally introducing both warp and weft into the worn-out parts as exemplified in Figs. 251 and 252. The former shows a damaged cloth partially repaired, while the latter shows a similar cloth wholly repaired. The plan is to stretch the fabric with the wooden embroidery rings, as shown in Fig. 253. The machine has a special form of presser foot, but there is no mechanical feed. The ring is moved by hand, backward and forward, until one set of threads are secure; the fabric and rings are then turned through 90°, and the second series of threads sewn across the first. The illustration in Fig. 251 shows only half the threads in each direction. Its special feature is that it shows part of the hole, both kinds of threads, and a finished part.

# INDEX

Accumulator, 58, 60, 69
—— instructions for handles of, 60, 62
—— pressure due to weights in, 66
Action of chemical agents on cloth, 256, 257
Air compressor, 281
Automatic feeder. *See* Feeder
—— guider. *See* Guider

B

Bags, 119
Bag cutting. *See* Sack cutting
Bags, arrangement of hems and seams in, 165
—— made by circular weaving, 142
—— method of forming, 163
Bag printing. *See* Sack printing
Beaming, 41, 47, 48, 52, 54, 62, 64, 65, 67, 294, 298, 299, 301, 302, 303
Beetle finish, 290, 292, 293
—— hammers in spring beetle, adjustment of, 306
—— —— in spring beetle, 300, 303, 304, 305, 306
Beetling, 22, 26, 40, 287, 292, 298, 299
—— duration of, 306
—— machine, 287, 290, 292, 294
—— —— spring, 292, 300
—— —— two distinct kinds of, 292
—— —— Wood Faller or Lancashire, 292, 300, 306
Belt stretching, 287
Belt stretching machine, 287, 288, 289
—— —— speed of, 290
Binding hoops, 122, 125, 127
—— ropes, 123, 124, 125
Birch's expander, 265, 266
Bleachfield, 85
Bleach-house, departments of, 248
Bleaching, 1, 22, 26, 229, 232, 247, 253, 256, 257, 258, 259, 310
Bleaching degrees of whiteness in, 247, 256, 258
—— in fields, 258
—— loss of weight in, 253
—— operations in, 248
—— powder, 256, 258, 259
—— risks, 258, 259
Bleachworks, 253, 255, 258, 259
Blue and bluing, 263, 264, 265
Boiling, 252, 253, 254, 255, 258
Branding. *See* Stamping
Brushes 12, 13

C

Caddis, 10
Calendering, 22, 33, 34, 36, 37, 39, 242, 283, 291, 307, 314
Calenderoy, 89, 91
Calenders, 23, 245, 290, 292, 306, 307
—— arrangement of bowls in, 26, 306
—— automatic stop in, 30
—— cotton bowls for, 291, 306
—— delivery of cloth from, 28, 32
—— designation of, 24
—— different types of, 26
—— driving of, 28, 292
—— functions of, 22, 23
—— paper bowls for, 24
—— pressure applied in, 24, 27, 28, 39
—— pressure of steam for, 26
—— speed of, 32
—— stripping in, 74, 86
Caves, 248, 254
Cellulose, 22, 244, 247
Chain of pieces for bleaching, 250, 251, 252, 253, 258
Chasing, 287, 290, 291, 292
Chemicking, 256, 257, 258
Chesting, 22, 28, 29, 30, 31, 33, 34, 36, 39, 294
—— double, 31
—— knife, 36
—— pressure applied in, 37
—— time allowed for, 31

Circular weaving, 142
Cisterns, 248, 254
Clips. *See* Stentering machine
Clock, 74, 75, 76, 106
Coloured yarns, bleeding of, 17
Combined dyeing, starching and drying, 238
Compensating rollers, 239, 271, 272, 274
Compressed air for guider and feeder, 280, 281
Conditioned cloth, 17, 294
Contraction in width of cloth, 33, 40
Cop machine, 172
Cops for sewing machines, 172
Cotton damasks, 292
Creasing. *See* Crisping
Crimpled paper for bags, 144
Crisping, 73, 84, 85, 307
—— and rolling machine, 92
—— machine, 84, 85
Cropping, 4
—— machines, 5, 8
—— —— delivery of cloth from, 8, 16
—— —— dust extractor for, 16
—— —— stop motion for, 10
Curvature of weft, 4, 33
Cutting. *See* Cropping

D

Damasks, bleached, 18, 85, 264, 271, 275, 276, 282, 290, 292, 309
Damask finish, 292
Damping, 17, 34, 37, 39, 40, 229, 230, 294
—— addition of starch etc. in, 18, 37, 229
—— duration of, 17
—— machines, 18, 19, 20, 21, 287
—— —— delivery from, 21
—— —— speed of, 18, 21
—— weight of water added in, 18
Darning by sewing machine, 319
Double chesting, 31
—— washing, 254, 258
Dressing, 253
Dry finishing, 229
Drying, 229, 232, 238, 240, 241, 244, 246, 269, 271, 272, 282
Drying cylinders or pans, 37, 269, 271, 272, 273, 276, 282, 287, 294
Drying machines, 236, 263, 264, 266
—— machine, vertical, 236
Dust extractor, 16
Dyed hessians, 241
Dyeing, 229, 238, 240, 241, 247
—— starching and drying combined, 238

E

Elastic finish, 282
Elmite, 210
Embroidery, 308, 314, 316, 317
—— rings or hoops, 319
Examining cloth, 2, 287
Expanders, 264, 265, 266, 269, 271, 272
Expanding, 260

F

Fabrics, cutting up of, 2
—— inspection of, 3
—— various kinds of, 2, 95, 308, 309, 310
Faking and faking boards. *See* Plaiting-down apparatus
Fallers for beetling machines, 293, 294, 295, 296, 297, 298, 299, 306
—— speed of, 299
Feeder, 276, 278, 280, 281
Feeding, 271
Finish, different types of, 72
Finishing, processes in, 2
—— reasons for, 1
Fishbacks, 264
Float expander, 264, 269
Folding. *See* Lapping
Folding and measuring machines, 96
Foxwell's guider and feeder, 276
—— —— compressed air in, 280, 281
—— —— pressure of air for, 282

G

Glazing, 32, 37, 40, 85, 232, 240, 242
Governor, 261, 262
Grassed, 258
Grey room of bleach-house, 248, 250, 252, 253
Grooved pulleys for winch, 256
Guider, 276, 278, 280, 281
Guiding, 271

H

Harrop's revolution expander, 269
Heating by steam, by coal-gas and and air, 26
Hem, regulation of width of, 179
Hemming machines, 175
Hemstitching, 308, 309, 310, 311, 312
—— withdrawing threads for, 310, 311
Hoops. *See* Binding hoops

Hoop bender, 128
—— cutter, 126
Horizontal drying machine, 232
Hot-air drying, 271, 272, 273
Hydraulic mangle, 49 *See* also Mangle, hydraulic
—— press, 119, 121
—— pressure, 49
—— pumps, 131

I

Identification marks, 206
Imperfect printing, 210
Importance of mechanical sewing, 317
Inclination of table in lapping machine, 112
Insertion work, 312
Inspection of fabrics, 2, 3, 287
Irregular shapes for bags, 160

J

Jigger, 229, 236, 238, 244
Jigging, 271
Jigging machines, 271, 281, 282, 286
—— stenters, 271, 281, 282, 286
—— —— drive for, 284, 285, 286
—— —— weft straightener in, 286

K

Kier, 252, 253, 254, 255, 256, 257
—— wagon, 253, 254
—— vertical, 255
Kieves, 248, 254

L

Lancashire beetle, 294, 300
Lapping, 73, 76, 79, 85, 95, 96, 98, 105, 106, 119
—— machines, 84, 98, 106
—— —— alteration of inclination of concave table in, 112
—— —— alteration of length of fold in, 103, 105
—— —— automatic control of table in, 108, 109, 110, 111
—— —— concave tables in, 97, 98, 112
—— —— convex tables in, 96, 111
—— —— defects in, 96, 112
—— —— folding cloth for sack making in, 105.
—— —— length of folds in, 96, 98, 114
Lapping machines, methods of depressing table in, 103
—— —— methods of operating grip rails in, 101, 107, 114, 117
—— —— rectilinear motion of blades in, 115, 116, 117
—— —— speed of, 104
Laundering, 314
Letters for printing, 210, 215
Lime boiling, 253, 255
Limepot, 252
Lime sour, 254
Liming machine, 251, 252, 254
Linoleum cloths, length of, 38, 84
Liquids for thinning colour, 227
Loading, 229, 240, 241
Lye boil, 255, 257

M

Macdonald's overhead sewing machine, 191
Mangle, accumulator in hydraulic, 57
—— automatic stopping of pumps in hydraulic, 59
—— automatic warning in hydraulic, 57
—— beaming motion of hydraulic, 47, 48, 52, 54, 62, 64, 65, 67
—— delivery of cloth from hydraulic, 39, 49
—— hydraulic, 39, 40, 46, 49, 69, 300
—— pressure in hydraulic, 39, 46, 47, 59, 64
—— rope drive for hydraulic, 49
—— rotating plates in, 52
—— safety device in hydraulic, 54, 55
—— self-acting reversing gear in hydraulic, 47, 55, 56
—— stone, 39, 40, 41
—— stripping motion in hydraulic, 47, 48, 54, 62, 64, 69
—— 3-Bowl starch, 236
—— top bowl positively driven in hydraulic, 47, 48, 52
—— working of rams in hydraulic, 63, 64
Mangling, 33, 36, 37, 39, 40, 67, 294
Marking, 76, 79, 80, 81, 82, 83, 146, 148, 250
—— machine, 76
Mather & Platt's kier, 253
Measuring, 38, 47, 73, 79, 82, 83, 98, 142, 150, 151, 154, 156
—— machines, 29, 73, 105
—— marking, and rolling machine, 76
Mending by sewing machines, 319
Mercerised cotton damasks, 292
Milk of lime, 252, 253

N

Numbering machine for printing, 227
—— —— —— sewing, 250

O

Opening winch or scutcher, 248, 258, 262, 263
Ornamentation of fabrics, 308, 309, 312, 314, 315

P

Packing, 84, 119
—— operation of, 122
—— press, 119
Padding cloths, different kinds of, 229
Paddings, black, 232, 239
Pans for drying. *See* Drying cylinders
Pantograph, 316, 317
—— embroidery machine, 316, 317
—— —— —— electrical stop for, 317
Paper bowls for calender, 24, 291
Paper-lined bags, 144
Perching room, 287
Plaiters, 312
Plaiting. *See* Lapping
Plaiting-down apparatus, 20, 47, 64, 74, 86, 94, 234, 237, 260, 263, 272, 276, 283, 284, 289, 290, 291, 302
Plan of bleach-house, 248
Press, hydraulic, 119, 121
—— pressure in hydraulic, 119, 121
Pressure of steam in drying machines, 237
Printing, method of, 208, 215, 217
—— on bags or sacks. *See* Sack printing
Pulleys, grooved, 256
Pumps, automatic change of pressure in hydraulic, 134, 135, 138, 141
—— hydraulic, 131, 137
—— pressure in hydraulic, 133, 135, 137, 141

R

Railing of cloth. *See* Tensioning
Reels, 256. *See* also Winch
Rigging. *See* Crisping
Riley's belt stretching machine, 288
—— stentering, etc. machine, 271
Roller washing machine. *See* Washing machine
Rolling, 79, 84, 85, 89, 91, 95, 119
—— machine, 76, 84, 85, 89
—— wide pieces, 38
Rope drive, 49, 69, 131
Ropes for binding bales, 123
Rot steep, 251
Round-thread finish, 31
Roy. *See* Calenderoy
Rubbing boards, 248, 258, 259
Rust, precautions against, 67, 252, 265, 266, 287, 300, 307

S

Sack cutting, 142, 145, 147, 148, 154, 156, 160, 164
—— —— frames, 142, 160
—— —— frame for long cloths, 145
—— —— machines, 142, 150, 160
—— —— —— automatic stop and recording mechanism in, 157
—— —— —— speed of, 152, 153, 154
Sack making, folding cloth for, 105
—— printing, 206
—— —— machine, adjusting the drums in, 217, 220
—— —— —— colour box in, 210, 213, 214, 224
—— —— —— colour or ink rollers in, 210, 212, 213, 220, 225, 228
—— —— —— gelatine rollers in, 210, 213, 217, 220, 225, 228
—— —— —— Keay's one-colour, 207
—— —— —— Keay's two-colour, 217
—— —— —— lateral movement of colour roller in Macdonald's machine, 225
—— —— —— Macdonald's one-colour, 224
—— —— —— Macdonald's two-colour, 218
—— —— —— mechanical stirrers in, 211, 214, 222, 224
—— —— —— new method for type in, 225
—— —— —— numbering machine for, 227
—— —— —— precautions against imperfect printing in, 210, 220, 228
—— —— —— substances used for letters in, 210, 215
—— sewing machines, 142, 162.
—— —— thread used in, 172, 175, 176, 185, 186, 195, 197, 202, 203
Saturating machine, 248, 253
Scalding, 257
Scallop, 312, 313, 314

Scrimp rails, 264, 291
Scrolls, 260, 261, 264
Scrubbers, 12
Scutchers, 248, 258, 262, 263
Scutching, 260
Second boil, 255
Second chemick, 257
Second scald, 257
Selvages, 31, 40, 65, 84, 90, 91, 156, 260, 272, 273, 274, 275, 280, 281, 284, 287, 288, 299
Sewing, 105, 119, 142, 163, 187, 190
—— fancy designs on cloth, 314, 315, 316, 318
—— machines, 94
—— —— alteration of length of stitch in, 171
—— —— barrel and contents in Laing, 188, 190
—— —— capabilities of Laing, 192
—— —— carriage in Laing, 190, 192, 194
—— —— cast-off wire in Yankee, 180
—— —— cone drivers in, 186
—— —— covers for, 184
—— —— delivery from, 185
—— —— direct pressure hammers in Macdonald's machine, 192
—— —— driving arrangements for Heracles and Yankee, 199
—— —— for zig-zag stitch, 201
—— —— friction tube in Laing, 189, 192
—— —— general description of working of lock-stitch, 166, 168
—— —— Heracles, 195
—— —— Laing or overhead, 185, 191
—— —— lock-stitch, 162, 165, 166
—— —— Macdonald's, 191
—— —— movement of feed dog in, 170
—— —— movement of feed dog in Yankee, 178
—— —— movements of loopers in Heracles, 197
—— —— movement of looper in Yankee, 177
—— —— needle in Laing, 190
—— —— needle movement in lock-stitch, 167
—— —— operation of sewing in Laing, 190
—— —— overhead, 165
—— —— shuttle and shuttle movement in, 168
—— —— speed of, 176
—— —— split nuts for carriage of overhead, 194
Sewing machines, take-up apparatus in Yankee, 179, 180
—— —— tensioning thread in, 167
—— —— tension of thread in Laing, 189, 192
—— —— times of movements in, 169, 171
—— —— times of movements in Heracles, 197
—— —— times of movements in Yankee, 183
—— —— two loopers in Heracles, 197
—— —— two sewing threads in Yankee, 179
—— —— Union or Yankee, 165, 176, 177, 184
—— numbers on cloth, 314, 315, 316, 318
—— thread, make up of, 202
—— —— supports for, 202
—— types of stitching or, 175
Souring, 254, 257
Specific gravity, 254, 256, 257, 258
Spirals for cropping machines, 4, 5, 6, 7, 9, 10, 12, 13, 14, 15
—— sharpening of, 7
—— speed of, 16
Spit for calenders, etc., 79, 90, 91, 94, 290
Spreading cloth in kiers, 256
Spring beetling machine, 291, 300
Stains, 67, 252, 265, 266, 287, 300, 307
Stamping, 105, 106
Starching, 229, 232, 235, 236, 238, 240, 241, 253, 271
—— and drying range, 232
—— mangle, 236, 260, 263, 264, 265, 266, 272, 276
—— substances used for, 240, 263
Steam pressure for calender, 26
—— —— in drying, 237
Steeping in spent lye, 251
Stentering, 271, 286
—— machines, 271, 272, 273, 274, 276, 278, 280, 282, 287, 299
—— —— alteration of rails for width in, 280, 284
—— —— clips for, 271, 272, 273, 274, 275, 276, 278, 280, 281, 282, 283, 284, 286, 288
—— —— drive for, 273, 284
—— —— speed of cloth in, 278
Stiffening, 229
Stone mangle, 39, 40, 41
—— —— beaming machine for, 41
—— —— pressure in, 44

Stone Mangle, stripping machine for, 46
Stocks, 259
Stretching, 264, 270, 271, 272, 276, 282, 287, 288
Stripping, 46, 74, 86, 294, 298, 299, 301, 302, 303

T

Tarring twine, 203
Tensioning of cloth, 4, 9, 12, 13, 16, 24, 32, 33, 34, 37, 41, 54, 64, 67, 78, 79, 91, 92, 106, 109, 151, 237, 272, 282, 288, 290, 298, 303
Tentering. *See* Stentering and Stentering machines
Third boil, 255
Third chemick, 257
Thread for sewing, 172, 175, 176, 185, 186, 195, 197, 202, 203
Transference of design to cloth, 314
Tucks, 312
Twaddell, 254, 256, 257, 258
Twine Tarring, 203

U

Union machine. *See* Sewing machines

V

Vertical drying machine, 236
—— kiers, 255
Vomiting, 253

W

Washing, 253, 254, 255, 257, 258
—— machine, 253, 254, 255, 257, 258, 260
Wash mill, 248, 259
—— wheels, 259
Water mangle, 260
Waterproofing, 243
—— substances used for, 243, 244
—— types of, 246
Weft straightener, 286
Whipping, 309
Winch reels, 252, 256, 258, 262, 281
Winding-on. *See* Beaming

Y

Yankee machine. *See* Sewing machines

Z

Zig-zag stitch, 201

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# INDEX TO ADVERTISEMENTS

PAGE
Boyd, J. & T., Limited . . . vi.
Carter, William, & Son . . . vii.
Cotton, Stephen, & Co. Limited . . . ix.
Craig, A. F., & Co. Limited . . . viii.
Foxwell, Daniel, & Son . . . x.
Hattersley, Geo., & Sons Limited . . . xii.
Keay, Thomas C. . . . xi.
Macdonald, D. J. . . . i. & ii.
Mather & Platt Limited . . . iv.
Parker, Chas., Sons & Co., . . . v.
Robertson & Orchar Limited . . . iii.
"Textile Manufacturer" . . . xv.
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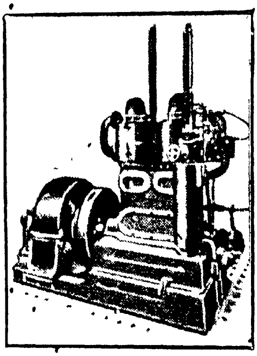

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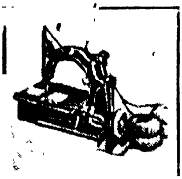

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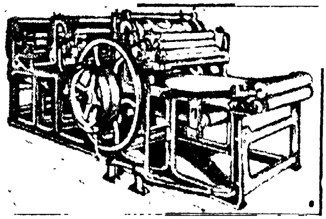

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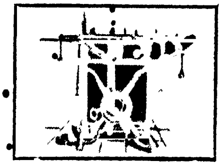

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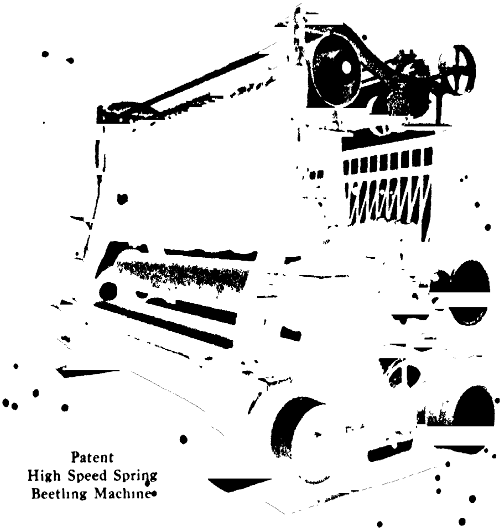

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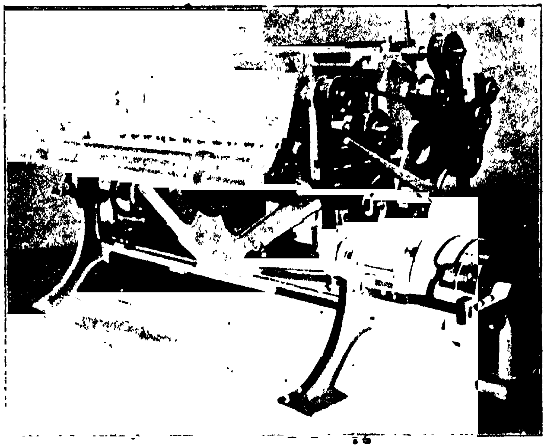

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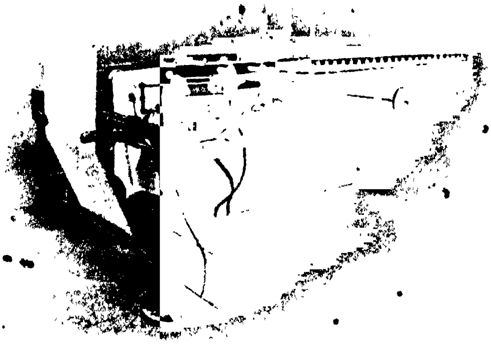

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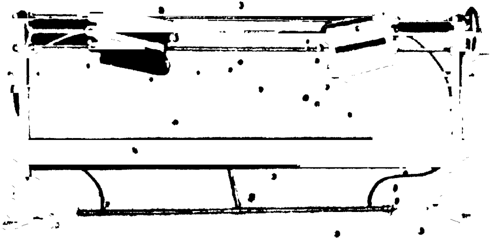

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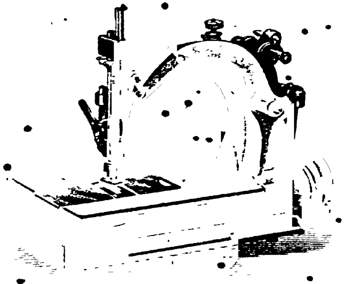

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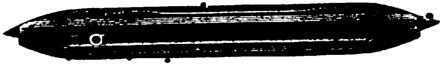

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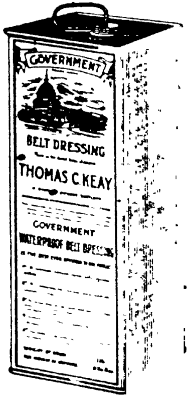

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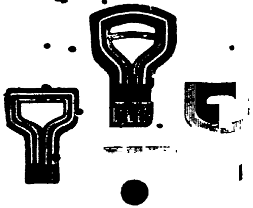

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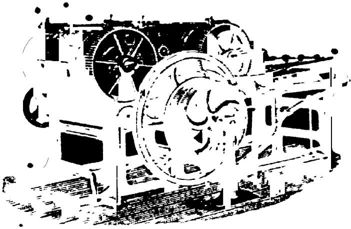

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